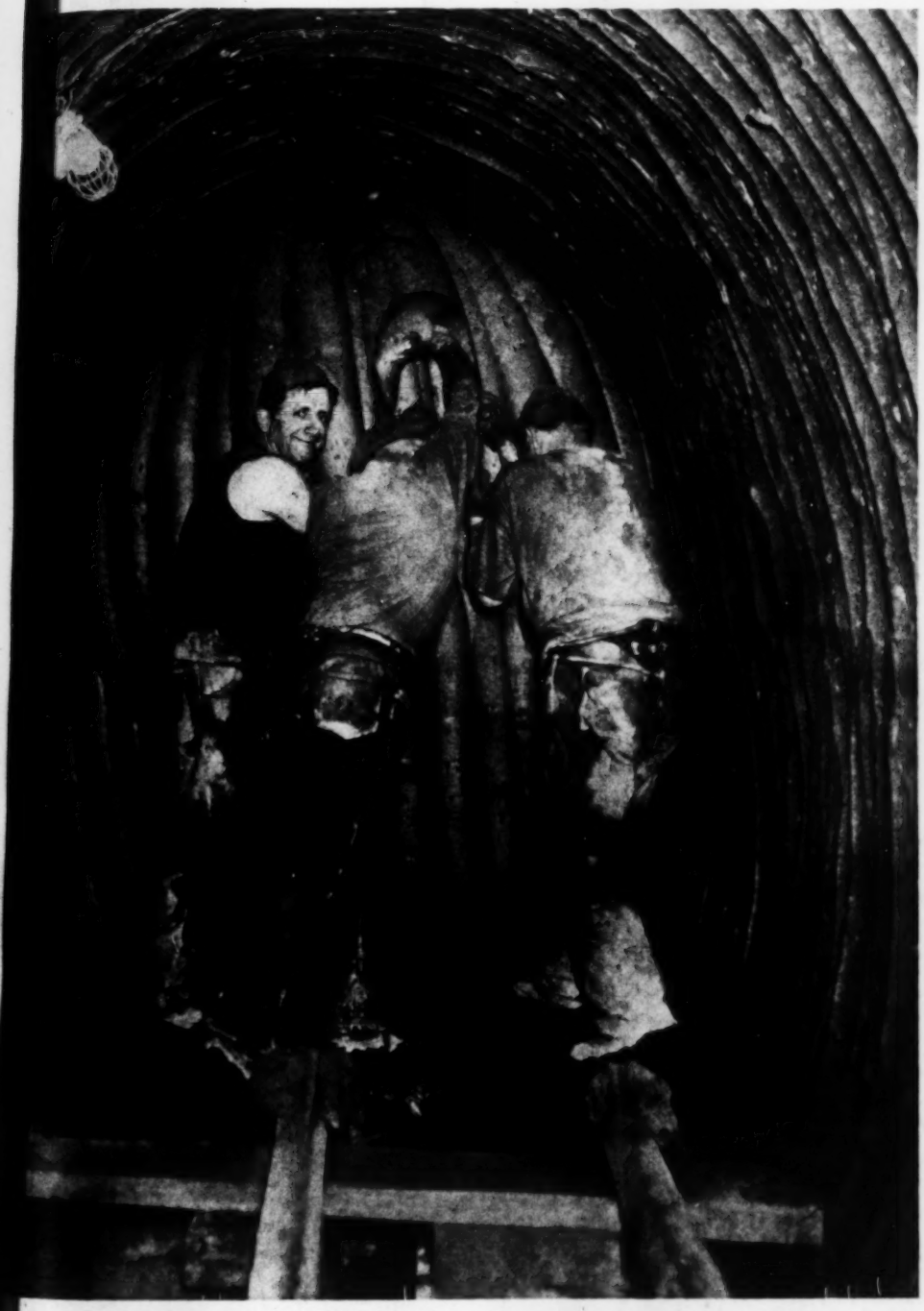
JUN 17 1935

Engineering News-Record

McGraw-Hill Publishing Company, Inc. June 13, 1935 Twenty-five Cents, Five Dollars per Year



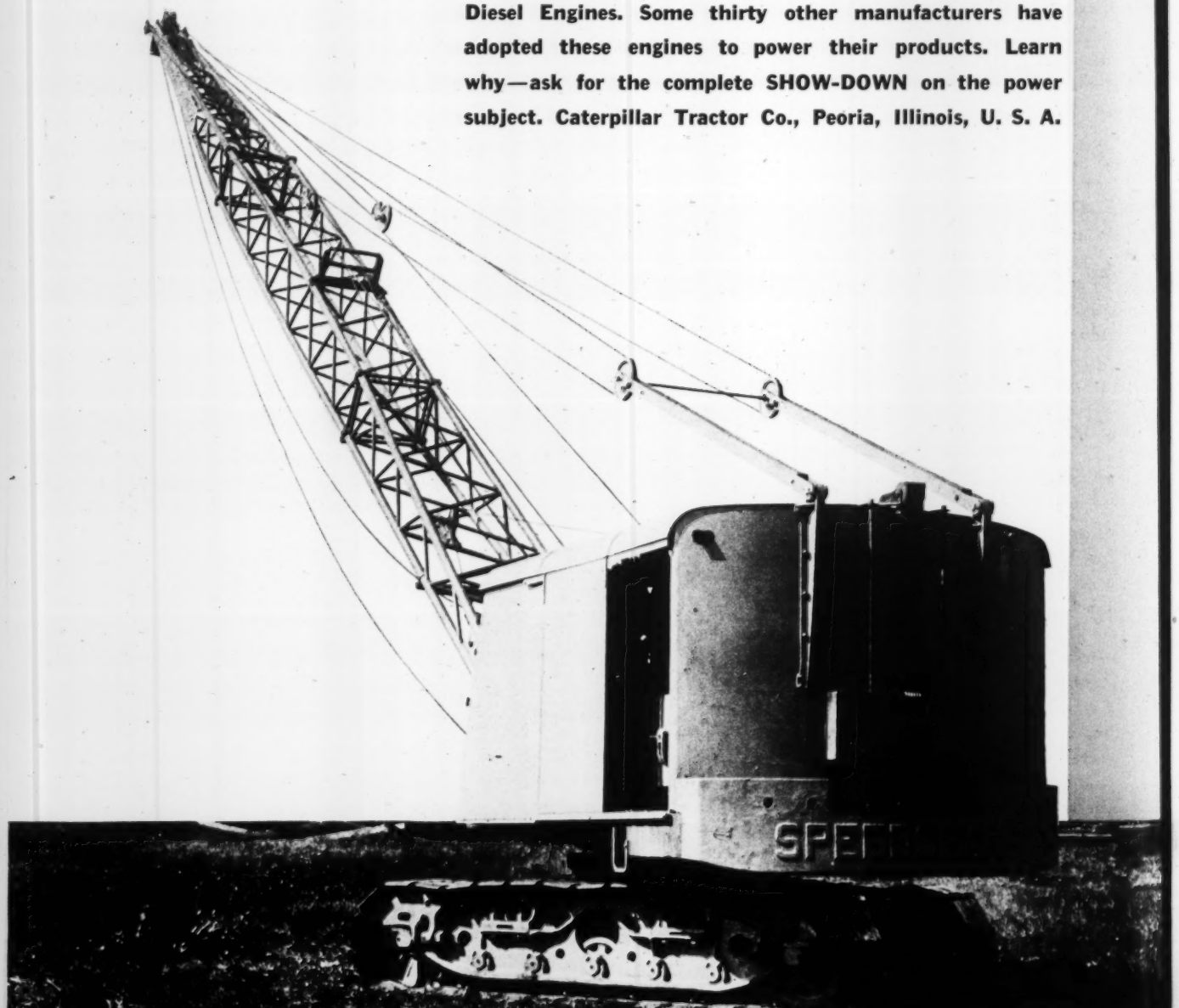
SLICING A SEWER TUNNEL through Chicago's blue clay, with two men on the knife and a third ready to catch the slab as it is peeled off

BEGINNING A SERIES OF THREE ARTICLES:

Constructing 27 Miles of Interceptor Tunnels for Chicago's Sewage

THE SHOW-DOWN
AT MANITOWOC

Building its Speedcranes on the basic principle of simplicity, Manitowoc Engineering Works of Manitowoc, Wis., demands that same quality in the power units for its equipment. "Caterpillar" Diesel Engines in the SHOW-DOWN gave proof of simplicity of design, operation, maintenance—plus dependability, responsive power, low fuel cost. Four sizes of Speedcranes are now offered powered by "Caterpillar" Diesel Engines. Some thirty other manufacturers have adopted these engines to power their products. Learn why—ask for the complete SHOW-DOWN on the power subject. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.



CATERPILLAR

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DIESEL

Lest Unwise Sharing Kill Production---II

(*Continued from the issue of May 30*)

TWO weeks ago this page pointed out that ill-considered efforts to effect a more rational distribution of the national income might well endanger the incentives that are responsible for our high industrial productivity.

We should make a grave mistake to assume that the scientific knowledge and mechanical plant through which we have achieved our productivity is the one key to our abundance. Much as that assumption might gratify our pride as engineers, we know that it cannot be justified.

The motive power that energizes all of our productive processes flows from those human impulses which animate men to devote their wits, their skill and their energy to create, manage or otherwise serve productive enterprises of many sorts. And if we are wise, we shall recognize that those impulses spring from no single human motive or instinct. It is idle for either extreme reformers or extreme reactionaries to assert that men do not and never will work except under one particular incentive, or that they would continue to work in the absence of that incentive. Every man is in himself a complex of instincts and motives, each exerting its influence upon him. Some respond more readily to one incentive, some to another; all vary from time to time in the strength of their reactions. No one can say with certainty what motives may best spur all men to effort under every condition of time and place.

BUT this we do know: unless we contrive at all hazards to conserve and nourish the human urge to greater productivity, we shall be lost. We know, too, that we shall do this with greater certainty so long as the economic framework within which we must function is adapted to our understanding and our habits of thought. As these may change with the unceasing march of human evolution, the system must readapt itself to suit them. But if we are to maintain unimpaired our interest, devotion and effort in the day's work, we should be able to see clearly and realize concretely certain definite rewards that will be reasonably commensurate with our individual wisdom, skill or energy.

It is true that great mass movements may be sustained for a time by an emotional force—a spirit of consuming fury, blind enthusiasm or unselfish devotion to an ideal. History is rich with examples. But if it is stable and enduring progress in an economic world that we seek, such emotional flares eventually must give way to the more constant glow of individual reward—gainful employment, contentment, security—with each individual, in the largest possible measure, determining his participation by his own efforts.

So, in our preoccupation with the problem of sharing more rationally the fruits of our increased productivity, let us beware of measures that may destroy those incentives which have been the motive power of our progress hitherto, and on which, until we can demonstrate the value of new incentives, we must rely for a continuance of our productivity.

And most of all, while we labor incessantly at this vital problem, let us remember that it is perennial. Happily, the ideals of each generation become in some measure the realities of the next, which in turn sets up for itself even higher ideals. So there is no reason for those who seek reform to be resentfully impatient and destructively intolerant. When, in the name of further progress, we forswear and denounce the work of those who have gone before and when we tear down what is sound merely because we think that we could do better, we may gratify our pride or our passions but we are not contributing to progress.

FOR all this is no new thing. Throughout the ages the hearts and minds of men have faltered as they sought to apportion rationally the fruits of man's efforts. More than two thousand years ago one of the wisest of men wrote, for us to ponder today in the midst of our strivings and perplexities, that "the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favor to men of skill; but time and chance happeneth to them all."

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 114, No. 24. Price 25c. per copy. Subscription, domestic, Mexico, Central and South American countries, $5 per year. Canada, including duty, $7.50. All other countries $9 a year or 36 shillings. Entered as second-class matter April 11, 1917, at the Postoffice at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C. Copyright 1935 by

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d Street, New York; 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.

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In the News:

IT IS TIME to deal with transportation as a unified problem, the President told Congress last week but consideration must now go over to the next session. Meanwhile he urged continuation of the post of federal coordinator of railroads and the placing of air transport and coastwise and inland water shipping under the I.C.C.

BIGGEST NEWS OF THE WEEK was the announcement of the President that work-relief projects should provide more field labor, largely by cutting down on materials. Average annual cost per worker can be only $1,143 if 3,500,000 men are employed for $4,000,000,000. Early projects authorized will cost $2,000 per worker, he said. The first result of the statement was an order from the Bureau of Public Roads to keep highway costs, including materials, to $1,400 per man per year.

SUPPORT AND OPPOSITION for Senator Wagner's bill to create a permanent federal housing bureau, to operate through local housing authorities, have been about evenly divided at the hearings.

MOST INDUSTRIES SERVING CONSTRUCTION express a wish to keep wage and hour provisions of their codes. Price changes since the ending of NRA have not been significant. The President has stated that the anti-trust laws are again in effect and that he must uphold them. These are the industrial developments of the week.

AN EXECUTIVE ORDER extending PWA after June 16, the date it was to expire, also contains permission for the PWA to sell its portfolio of securities directly instead of through the RFC and to use the proceeds for further loans.

ANOTHER EXECUTIVE ORDER extends the life of the National Resources Board. It will now be known as the National Resources Committee. Personnel is unchanged.

RAILROAD COORDINATOR EASTMAN has just made a new set of proposals to the railroads, most of which relate to freight rates and classifications, but others (such as changes in operating methods, use of lighter equipment and changes in terminal services) are of direct interest to engineers in the railroad field.

THE "PORTLAND ROSE" of the Union Pacific System, a diesel streamlined seven-car passenger train, has made the 2,250-mile run from Portland, Ore., to Chicago in less than 40 hours, or more than 19 hours less than the present schedule time.

FLOOD DAMAGE in Colorado, Nebraska, Kansas and Missouri has been estimated at more than $40,000,000. Stages in the Kaw River, which carried the Nebraska floodwaters across Kansas to the Missouri River, were about equal to those of the 1908 flood, and at Manhattan equalled those of 1903. The Kansas City levee system built after the lessons of the 1903 and 1908 disasters gave adequate protection.

GRADUAL INCREASE in industrial activity is forecast on the basis of maintained output of electric energy, according to *Electrical World's* analysis. In addition, that paper reports the output of current to be nearly up to peak figures; April production was only 2½ per cent under the top record, for April, 1930.

VOLUNTARY CONTROL is proposed by copper producers in view of the failure of NRA code control.

In This Issue:

SETTLEMENT of the rockfill dam of the Los Angeles County Flood Control District, known as San Gabriel Dam No. 2, cracked the concrete facing so badly that it had to be removed. An interesting timber facing was substituted, whose flexibility is counted upon to keep it intact under any further settlement.

LABORATORY DETERMINATION of optimum soil moisture by use of briquette pressure apparatus is described by B. G. Zimmerman, of the University of Texas.

DENMARK'S GREAT NEW BRIDGE over the Little Belt, which was opened last month amid national holiday festivities, involved remarkable foundation methods and ingenious steel erection during its construction. These are described by the chief engineer of the Danish State Railways, who had charge of design and construction.

TWO EXAMPLES of cement-macadam road construction indicate that this cement-penetrated stone surfacing can be improved by adaptation of reinforcing steel and contraction-joint practices. Also that highly mechanized procedures are practicable. Both jobs were done by inexperienced labor.

JOHN F. STEVENS, in his seventh article, recalls his years as chief engineer and general manager of the Great Northern Railway System, and gives a new insight into the character of that most interesting of railroad builders, Jas. J. Hill.

CHICAGO IS BUILDING some 27 miles of intercepting-sewer tunnels that will take sewage now discharged into the famous drainage canal to new sewage-treatment plants. Driven through all kinds of ground and in diameters from 4 to 17 ft., the tunnels represent notable construction. The first of three articles describing plant and methods used by contractors on these tunnels appears in this issue.

BEHEMOTH, TAKE A BOW!

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Owned by M. A. Breymann. Operates a 17-yard bucket for hard digging—a 28-yard bucket for soft digging. 150 feet in length—55-foot beam—12 feet from deck to bottom. Boom 85 feet long—10-foot boom sheave. Has largest main hoist rope ever built for this type of equipment!

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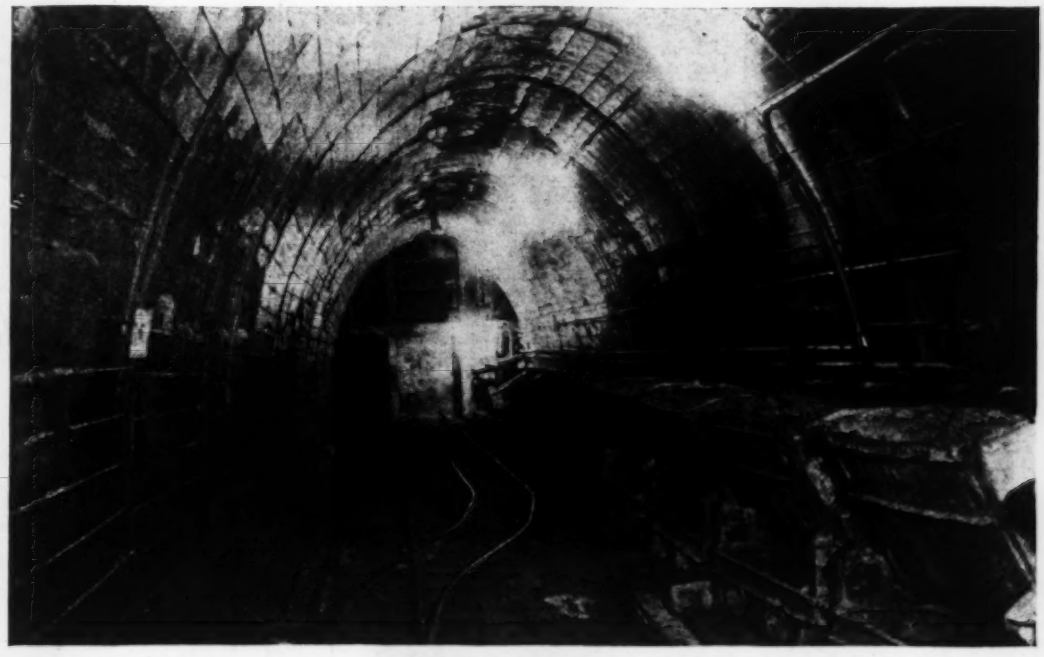


FIG. 1—TYPICAL concrete-lined intercepting-sewer tunnels that will serve Chicago's West Side treatment works.

Sewer Tunnels Reduce Pollution in Chicago Drainage Canal

Extensive intercepting sewer program involving 27.2 miles of tunnels from 4 to 17 ft. in size, driven through all kinds of ground to serve West Side and Calumet treatment plants, is part of Chicago's effort to comply with the Supreme Court decree that cuts down canal-water diversion from Lake Michigan

First of Three Articles

BY DRIVING 27 miles of intercepting sewer tunnels through sand, rock and the characteristic Chicago blue clay, and building two new disposal plants and extending a third, the Sanitary District of Chicago is completing a plan for treating practically all of the city's sewage. This plan will supplement the world-famous dilution system, completed in 1900, involving the reversal of the flow of the Chicago River. Growth of population and periodic reduction of diversion of Lake Michigan water through the river ordered by the U. S. Supreme Court necessitated the treatment system. By the end of 1938 diversion from the lake must be reduced to 1,500 sec.-ft. The entire program, including four treatment plants, interceptors and appurtenant works, will cost over $212,000,000.

Anticipating the ultimate need of disposal other than by dilution, the Sanitary District as far back as 1908 began a study of sewage treatment. A plan was developed involving four treatment plants—Calumet, North Side, West Side and Southwest (Fig. 2). The first plant built was the Calumet station, consisting of 30 Imhoff tanks, two experimental activated-sludge units and a small trickling filter. This plant is now treating 56 m.g.d. A new activated-sludge plant, fed by a network of interceptors, is now under construction near the old Calumet plant, designed to serve an area of 88 square miles, embracing all of the area south of 87th St. and each of South Crawford Ave. The plant will treat 136 m.g.d. from a population of 455,000. The effluent will be discharged into the Calumet Sag channel.

The North Side plant, using the activated-sludge process entirely, was completed, along with necessary intercepting lines, in 1928. It now treats 200 m.g.d., serving the entire area north of Fullerton Ave., including North Shore suburbs, an area of 62 square miles with a population of 1,100,000. Sludge from this plant is pumped through a 17-mile force main to the West Side works, recently completed.

The West Side plant, consisting of three batteries of Imhoff tanks (108 units), is now completed to its planned capacity. It is located on the main

drainage canal just west of the city limits. At present this plant is treating 130 m.g.d., in addition to 2 m.g.d. of sludge received from the North Side works. Eventually this plant will serve the entire central business and industrial section of the city, including the Loop business district. Interceptors necessary to complete this service are now under construction.

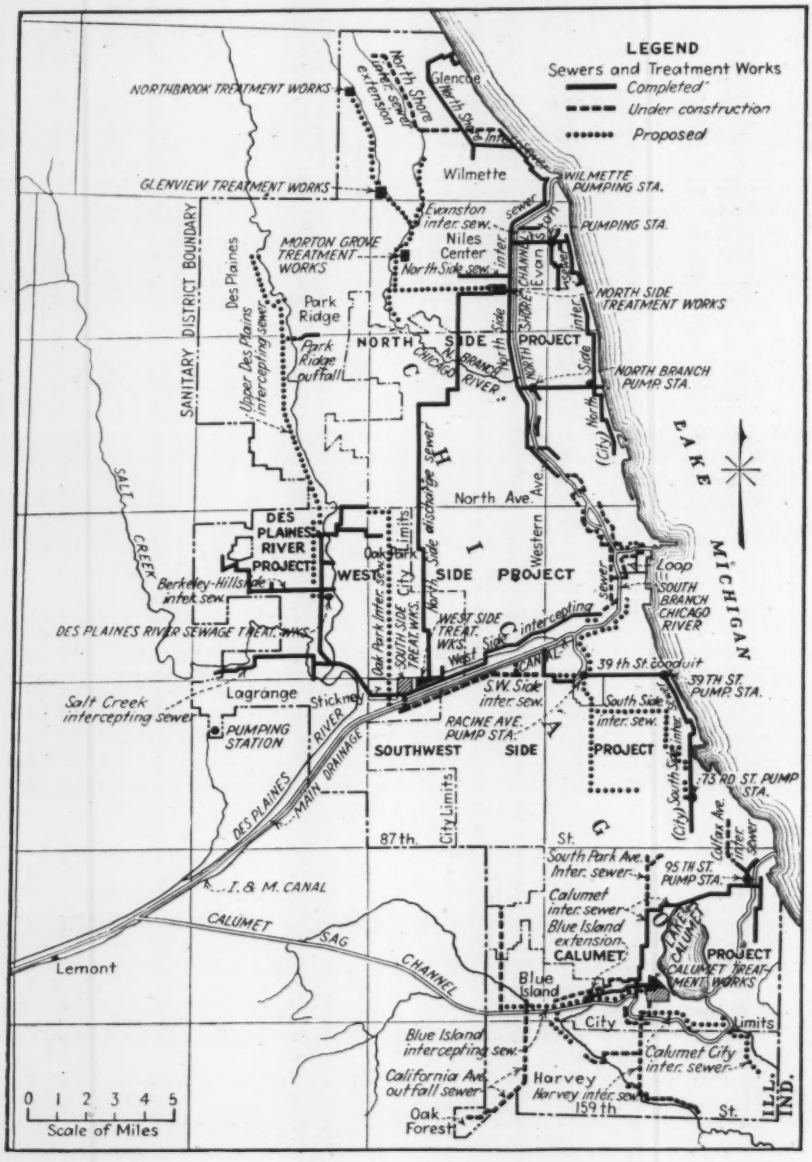
The fourth large unit in the disposal system will be the Southwest activated-sludge plant, to be built in the town of Stickney, on the north bank of the drainage canal just west of the West Side works. Contracts for the aeration tanks and the first section of intercepting tunnels for this plant have just been let under PWA financing. These works are designed to treat 400 m.g.d.

As a temporary measure, to clean up pollution of the Des Plaines River draining the northwest corner of the Sanitary District, small Imhoff tanks are being built at the outlet of several large sewers now discharging into the river. As the population increases, this area will eventually be served with a series of interceptors leading to one of the existing plants or to a new plant.

In addition to the disposal plants and interceptors, the Sanitary District has built several pumping stations required for boosting the sewage flow over a wide flat metropolitan area.

The Sanitary District is now completing 20.6 miles of reinforced-concrete intercepting sewers tributary to the West Side treatment works, and 16 miles of lines leading to the new Calumet plant, to divert the sewage from an area of 41 square miles (population 1,025,000) away from the Chicago River and main channel. This work is to be completed before the flow of diluting water from Lake Michigan is reduced to 5,000 sec.-ft. on Dec. 31, 1935, to comply with the Supreme Court decree. It is being done under nine contracts totaling $10,072,674, financed through a PWA loan and grant. Nearly all of the interceptors are being built in tunnel with only minor disturbance to street traffic.

FIG. 2—RELATION of present and proposed Chicago sewer projects to those already completed. Eventually the sewage from the entire city and surrounding suburbs will be treated before it reaches the famous Chicago Drainage Canal.



Character of ground

The route of the interceptor crosses a low subsurface ridge of rock nearly 2 miles wide. Except for this section, the excavation is in earth of widely varying character with irregular beds of clay, sand, peat and loam, although the peculiar Chicago blue clay predominates. The outlet of the glacial Lake Chicago traversed this territory, which accounts for the great variety of subsurface formations. This area was burned over during the famous Chicago fire, and much of the debris from the conflagration was piled in the streets, raising the street level as much as 10 ft. in places. This superimposed fill of

pervious, and now saturated, debris and the character of the underlying materials have necessitated the use of compressed air in driving most of the tunnels in this area. Practically all of the tunnels are adjacent to river channels and are far below groundwater level.

Design of tunnels

For all of the tunnels the Sanitary District has adopted a reinforced-concrete horseshoe section with a curved invert. Regardless of size, the proportions of width and height remain practically constant. Thickness of walls, arch and floor and amount of reinforcing naturally vary with the character of ground. Typical cross-sections are shown in Fig. 4.

This design, essentially an elastic ring, was selected in preference to other cross-sectional shapes because it embraces the theoretical resistance line for all anticipated conditions of soil pressure, including horizontal and uplift pressures resulting from near-by heavy buildings on floating foundations. Normal reinforcement is from one third to one half of the theoretical maximum, which makes it easy to gain extra strength by merely adding the required steel. Extra reinforcing is placed where it is anticipated that future construction, such as subways, may change the soil pressures. From a hydraulic standpoint this section is almost as satisfactory as a circle, and it offers the decided advantage of a nearly flat floor for construction operations.

For the most part the interceptors follow the street lines, resulting in numerous sharp curves. Occasionally, especially in crossing railroad lines, easements through private property are necessary. In general, the tunnels are deep enough to miss the maze of subsurface utilities, with the exception of some water tunnels and the extensive Chicago freight-tunnel system, a privately operated underground railroad. The freight tunnels are deeper than the sewers, but in many places the cover between the roof of the railroad tubes and the bottom of the sewer invert is scant, and the rumble of trains passing underneath can clearly be heard in the sewer headings. At one point where the sewer line lies above an existing water tunnel, special waterproofing treatment was given the sewer tunnel by installing a membrane against the temporary steel-plate lining prior to placing the concrete in the sewer structure.

Existing structures interfere to some extent. Underneath Wacker Drive, on the south side of the main river, the sewer tunnel winds in and out between the viaduct caissons and piers and also swings around a high-pressure water main. Ventilation ducts installed to clear the air in the lower level of Wacker Drive (but never used) are traversed by special sections. The corresponding sewer on the opposite side of the river passes below the LaSalle St. streetcar subway under the river.

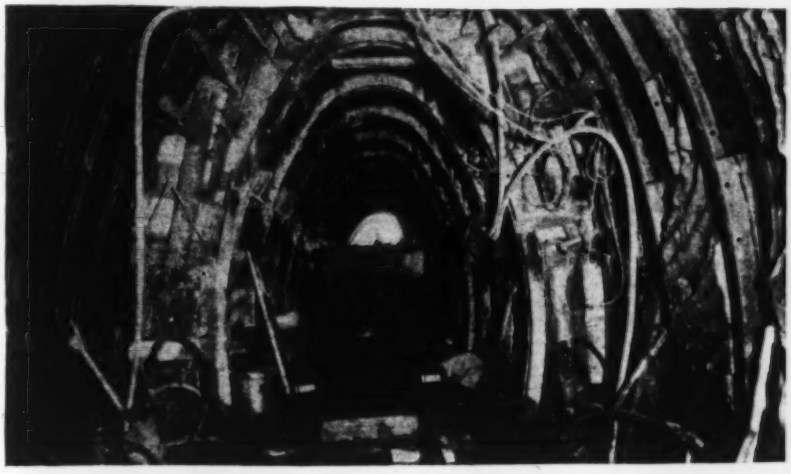


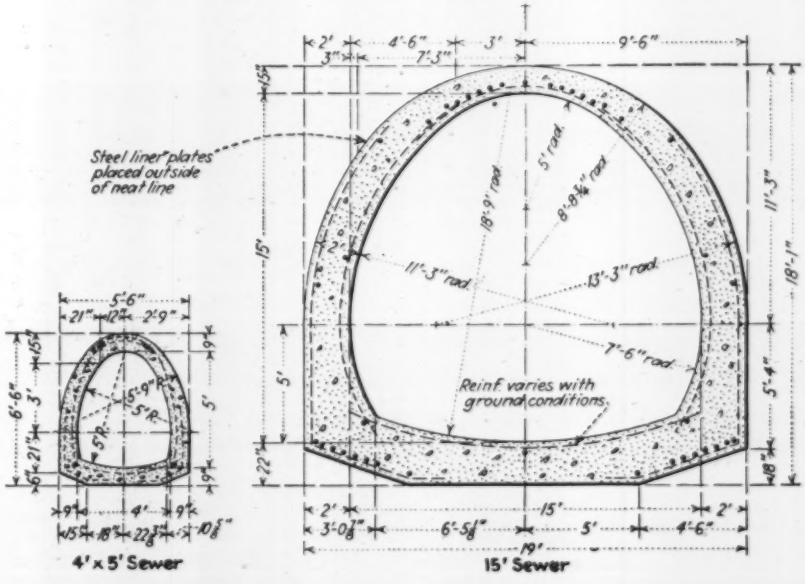
FIG. 3—TUNNEL DRIVING through typical Chicago blue clay, under air. Temporary steel-plate lining is used in soft formations, and the concrete lining is always carried close to the heading face.

Siphon river crossings

The West Side intercepting sewers cross the river at three points in siphons. At Taylor St. the Loop line crosses the south branch of the river in a double-barreled structure in solid rock at a depth of 85 ft. below water. A larger three-barreled siphon was required for the crossing of the north branch of the river at Kinzie St., where two intercepting lines join for the river crossing. A third crossing, 48 ft. below water level at Cortland St., will consist of two 36-in. cast-iron pipes encased in concrete. It will serve the area north to Fullerton Ave. and east of the river. The top chambers of the siphons are fitted with stoplog arrangements, to provide for flexible operation of one or more barrels. Fig. 6 shows the west shaft of the Taylor St. siphon.

Both siphons were built without the use of compressed air from steelsheeted shafts. At the Kinzie St. crossing three shafts were sunk from the floor of the junction chamber, and three independent barrels were driven from the bottom of the construction shafts. At Taylor St. the full area of the two risers and barrels was excavated through rock as a unit, with the individual barrels and riser pipes being formed by the concrete sections. Incidentally, construction of the siphon shafts required the tying back of adjacent river dock walls through a system of rods, beams and deadmen.

FIG. 4—TUNNEL CROSS-SECTIONS are designed to take unequal pressures on all sides. The flat bottoms make driving easier.



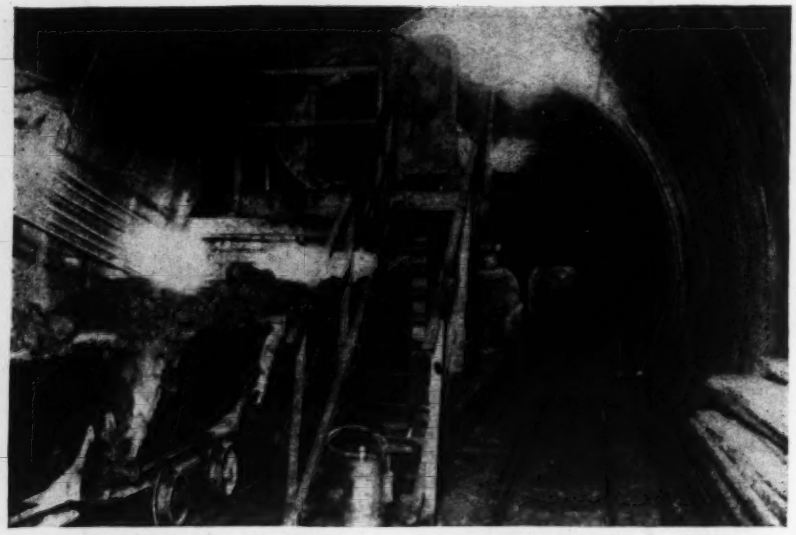


FIG. 5—SAFETY FEATURES dominate the tunnel projects. Here is an emergency lock directly connected to a shaft leading to the street in one of the 17-ft. sections. The lock is moved ahead as driving progresses. In the background is the permanent lock at the foot of the construction shaft.

The existing main trunk sewers, built by the city of Chicago, are connected with the intercepting tunnels through connection chambers fitted with automatic gates, to regulate the stormflow into the interceptor. These connection chambers are built by the tunnel contractors from the surface, with usually only a junction opening being blocked out of the tunnel lining, though occasionally a short stub connection is driven from the tunnel.

The automatic gate, fitted with counterweights and adjustable to any range of stormflow desired, was developed by the Sanitary District engineers. A new feature at several locations, in addition to the counterweight control, is a float control that operates in a separate well connnected to the interceptor and regulates the inflow according to the depth of water in the tunnel. By elaborate experiments and from experience the district engineers have developed a design of drop connection between the gate chamber and the interceptor that dissipates the energy of the fall. The controlling feature of this design is the depth of backwater in a stilling pool at the foot of the drop.

Some of the contractors build the connection chambers along with the tunnels; others make it a subsequent operation. Construction of the chambers is troublesome, because the flow through the existing sewer must be maintained until the interceptor is placed in operation; being built from above, subsurface utilities are usually in the way. The chambers and shafts are usually sheeted with steel or wood sheet piling, though on some occasions tunnel liner plates placed in horizontal rings have been used for ground support.

The intercepting lines tributary to the new Calumet plant total 34,820 ft. in length, including 26,760 ft. of concrete sewers built in tunnel, 8,060 ft. of vitrified pipe encased in concrete laid in open cut, and three crossings under the shallow Little Calumet River. Shafts 8 ft. in diameter were sunk from 600 to 800 ft. apart, usually at manhole stations, on line of the tunnel. The soil varies from a hard clay requiring no support to mixed soft materials requiring steel-plate lining and 12 to 16 lb. of air pressure. River crossings were built in open cut within cofferdams.

Concrete specifications

Concrete is mixed under rigid specifications to develop compressive strength exceeding 2,400 lb. per sq.in. at seven days and 3,000 lb. at 28 days, using 1 part cement to 7 of fine and coarse aggregates combined as required to secure the desired workability and to produce a dense watertight concrete with smooth finish. A water-cement ratio of not less than 4 nor more than 7 gal. per sack of cement is rigidly maintained. Mixing time is specified at least 1 min., and the concrete must be placed in the forms within 45 min. after it has left the mixer.

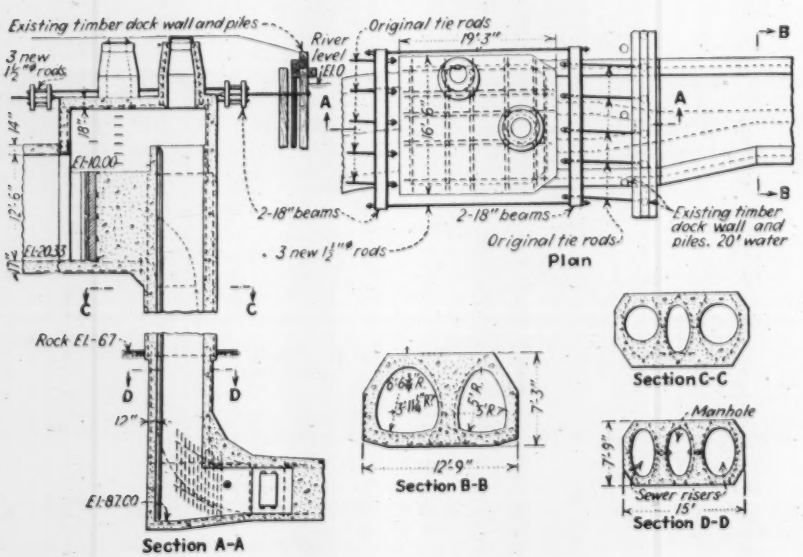
Fire changed methods

Work started in 1930 on the first two sections of the present project, known as contracts 3 and 4. On April 13, 1931, a disastrous fire occurred in the heading of contract 3, resulting in the death of eleven men, some of them city firemen (*ENR*, April 23, 1931, p. 701). As a result of this fire, tunneling methods were changed and many safety precautions were adopted that are in use today.

In response to recommendations made by the coroner's jury following the fire, the use of timber cants and temporary bracing was discontinued, and steel-plate lining was substituted for support of the ground. Shafts, headframes and headhouses were rebuilt of fireproof materials. Emergency exits equipped with locks were installed in the headings and moved ahead from time to time. Waterproof telephones were installed at shaft bottoms and in headings, connected to the shaft house, and the contractors' and engineers' offices. A large-scale diagram of the shaft, locks and underground works was required to be placed at the top of the shaft as a guide to rescuers in the event of emergency.

Further safety precautions include the installation of dependable gas masks at each heading in sufficient number to supply every man underground. In case of gas or smoke these masks are

FIG. 6—SHAFT STRUCTURE used where the West Side interceptor lines cross the Chicago River. Note the steel cradle necessary to carry the timber dock-wall tieback system around the shaft structure.



good for 30 min. A safety lamp is kept burning at the face of the heading, a fluttering of a tiny flame in this lamp instantly serving as a warning in case of dangerous gases. Periodic tests are made of the CO content of the atmosphere.

Probably the most important safety feature is the training of at least seven men on each shift as a rescue crew. To date, 113 men on the projects have received certificates for their mine-rescue training. Two-hour McCaa gas masks for these rescue crews are kept in glass cases near the top of the shaft. Fire extinguishers are placed at strategic points within and without the tunnel. All engineers are required to wear hardboiled hats, and most of the contractors require their workmen to use them also.

These safety precautions have resulted in remarkable freedom from accidents.

FIG. 7—IN THE SMALLER sewer tunnels the structure approaches midget proportions. Here is the concrete lining just placed in a 4x5-ft. section, with the forms not yet removed.

Every contractor is required to employ a safety engineer, and every resident engineer and inspector is charged with the safety of the job. New specifications for the Southwest interceptors are even more stringent. They bar, for the first time, the use of animals underground, eliminating mule haulage. Shafts must, in the future, be equipped with hoisting engines and skips or cages operating in guides, doing away with bucket or box hoisting by a crawler crane, as may now be used.

Specifications for air equipment are rigid. The minimum number of compressors and their capacity is stipulated. Two independent sources of power must serve the compressor plant. Duplicate air lines must be provided for the tunnel, and specifications provide for safe pressure reducers, air-relief valves and a siren warning when the air pressure drops to dangerous limits within the tunnel.

FIG. 8—PLACING THE LINING in the double-barreled siphon at Taylor St. below the river in solid rock. The siphon was excavated as a large tunnel, and the two barrels were formed by the concrete structure. Reinforcing for the adjoining barrel is at the right.

After the fire, work was resumed on contract 3 under a supplemental contract on July 4, 1931. But financial difficulties of the Sanitary District late that year forced a cessation of all work on Dec. 31. It was resumed about a year ago, again under supplemental contracts, after the District was allotted a PWA loan and grant.

Within a short time after approval of the PWA loan, work on contracts 3 and 4 was resumed, and contracts were let for the remainder of the West Side intercepting system. Three more sections have now been completed, and by the end of this year it is expected that practically the entire system will be complete.

Driving and lining methods and details of plant layouts and equipment will be described in detail in subsequent articles.

Direction

For the Sanitary District of Chicago, Philip Harrington is chief engineer and William H. Trinkaus, Jr., is assistant chief. Sewer work is under the direction of Walter H. Faget, principal construction engineer of sewers, and Orville L. Eltinge, engineer of sewer design.

Resident engineers on sewer construction include N. M. Newlands, J. P. Della Maria, J. H. Richmond, R. F. Kelly, L. L. Bradish, J. W. Grimm, G. L. DeMent, W. E. Gunlock and Harry Bartz. Joshua D'Esposito represents the PWA as resident project engineer on the Sanitary District work. C. H. Bauer is PWA state engineer inspector for Illinois.

Contractors on the several tunnel projects are: West Side contracts 5 and 6 and Harvey interceptor, S. A. Healy, Chicago; West Side contract 3, D. Ryan Co., Chicago; contracts 4 and 7, Ready Coal & Construction Co., Chicago; contract 8, Michael Pontarelli, Inc., Chicago; contract 9, Paschen Bros. Construction Co., Chicago; contract 10, Commonwealth Improvement Co., Chicago; Calumet Division, H. McKay Engineering and Construction Co., Chicago.

Trees and Shrubs Required Along New York Highways

Cuts and fills made incident to future construction or improvement of any state or county highway must be suitably protected against erosion by the planting of trees and shrubs, according to mandatory provisions of a law that has just been passed by the New York legislature and signed by Governor Lehman at Albany.

Under the law, the superintendent of public works is charged with the responsibility of directing such planting. All future highway improvement contracts are expected to include items of trees and shrubbery.

The superintendent of public works is given discretion to have similar planting done along existing highways where trees and shrubs do not already exist, and where, in his opinion, they would be desirable. The planting is to be financed out of funds ordinarily made available for construction and reconstruction work. Under the law the department may let the planting on a contract basis or do the work with its own forces.

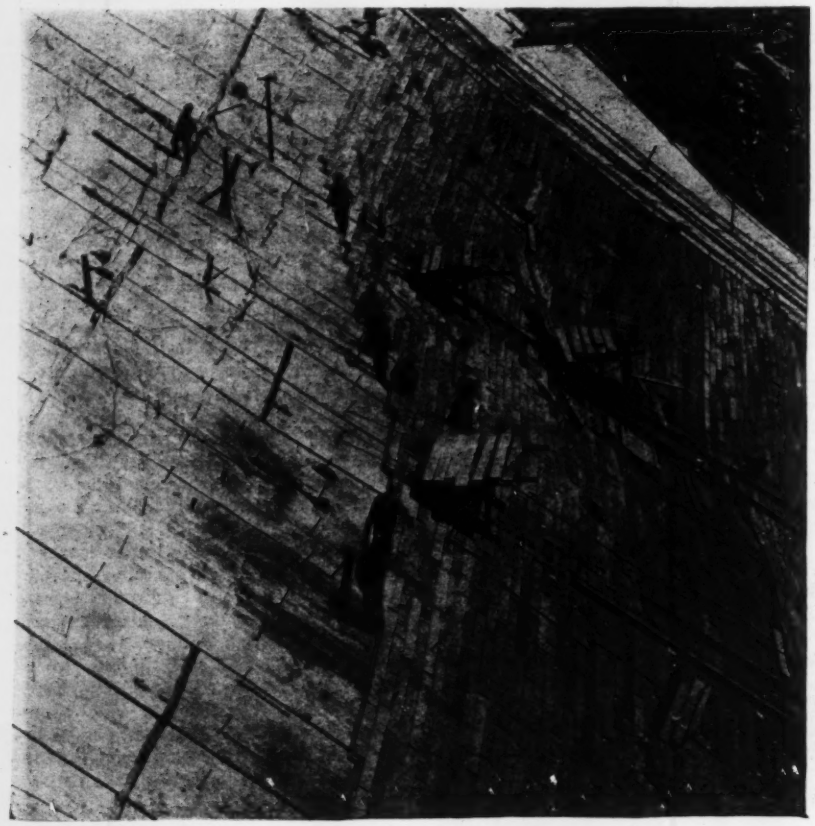
Flexible Timber Facing Applied to San Gabriel Dam No. 2

Repair of rockfill includes removal and replacement of 75 per cent of old concrete facing that was cracked in settlement, dumping 60,000 cu.yd. of additional rock and reconstructing the crest

PLANS for reconstruction work and additions to San Gabriel Dam No. 2 of the Los Angeles County Flood Control District were revised several times, and there was some delay in progress of the work. However, work went forward actively during the past winter, and the job was completed in the late spring. The items included removal of about 75 per cent of the old Gunite top slab and concrete subslab on the upstream face, pouring new concrete subslab and placing over it a facing of timber, dumping an additional 60,000 cu.yd. of loose rockfill on the downstream face and finishing off the top of the dam with a hand-packed wall or parapet along the crest above a tier of reinforced-concrete ribs topping the upstream slope.

Contract for removing the old Gunite facing and subslab and replacing the latter was let subject to later decision as to the exact amount to be taken off. When the work was well under way the old subslab was found to be in such bad condition as the result of fractures and buckling caused by settlement that much more was taken off than had been expected at the outset. The amount of Gunite top slab and concrete subslab removed totaled about 7,500 cu.yd. and about 75 per cent of the original concrete subslab was replaced. The timber facing includes about 941,000 ft. b.m. of timber, in addition to which about 375 cu.yd. of concrete was poured in place in the concrete ribs near the crest. A general description of the work appeared in *ENR*, March 7, 1935, p. 345. In that article is included a drawing showing details of the timber facing.

FIG. 1—FACING DAM with two plant units hauled up on incline cars. The third or top plank has been placed in right background. Projecting bolts are for fastening the wales in place; holes for these bolts were bored in planks and in wales as the timber was placed. Tightening nuts on the bolts clamped wales and planks together.



Method of removing original facing

The method of removal developed after some experiment was to lay off each 30x30-ft. panel of the top slab into eight 7½x15-ft. sections and then to perforate the outlines of each section with 2-in. drill holes spaced 6 in. on centers. Having thus weakened the edges of a small section, a cable was fastened to it by means of a hole drilled at its center, and the section was jerked free by a dragline mounted on the side of the canyon near the upstream toe. The sections pulled out were from 4 to 8 in. thick; the top slab was mostly 4 to 6 in. thick. As the sections were broken free they were pulled down to the toe of the slope and there piled up out of the way of operations on the timber facing. Removal of the face required more time than had been estimated because it was found that while the top slab came away with unexpected facility, yet it was necessary to suspend all other operations on the face of the dam lower down while the slab removal was under way because of danger to workmen from fragments sliding down the face.

Fig. 3 shows the work when about half of the top slab had been removed. The darker areas on the lower half of the dam are subslab exposed after removal of top slab. The still darker areas above the top-slab panels indicate portions of the subslab on which reinforcing for the top slab had been placed but on which the top slab never was placed; work on the original facing was stopped before final completion. The top slab to the right of the ladder and above the abutment angle at about mid-height of the dam, was pronounced undamaged and was not removed. Timber facing was not put on this part of the upstream face.

The new facing

Failure of the original facing of concrete and Gunite was ascribed to settlement of the supporting rock in an amount greater than would permit the facing to retain its integrity. In planning a new facing to be substituted for the one removed, the objective was to adopt a design that could be depended upon to remain reasonably watertight even after considerable additional settlement. It was assumed that the dam might again settle as much as it had previously—an assumption believed to afford a wide margin of safety. A board of consulting engineers (Harza, Steele and Reed, *ENR*, March 7, 1935,

FIG. 2—BROKEN UP BY SETTLEMENT, upstream facing is shown prior to removal. The pick lies on the concrete subslab; other shattered sections are parts of the top slab.

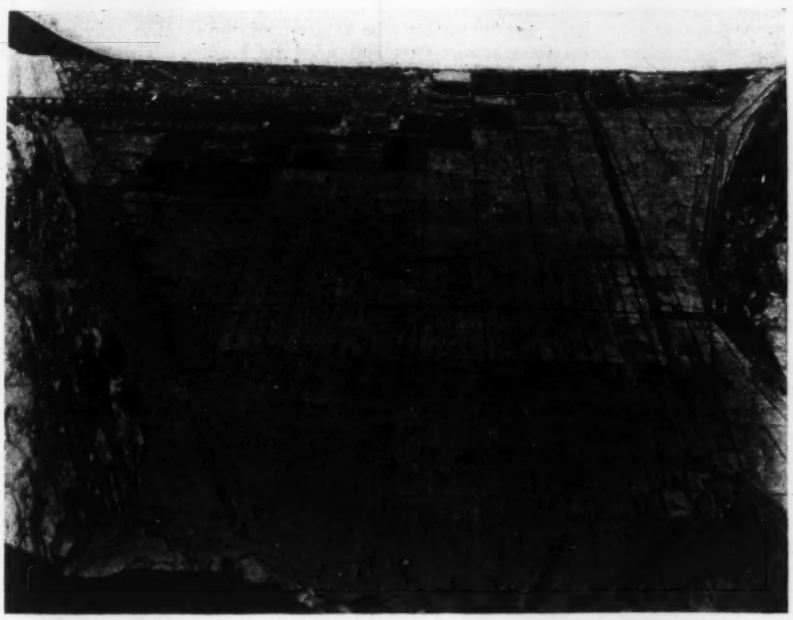


FIG. 3—REMOVING SHATTERED FACING in 7½x15-ft. sections by means of lines from dragline shown in lower foreground. In left foreground removed slabs are piled at toe.

p. 344) suggested a timber facing. At the request of the state engineer their design subsequently was changed to increase its flexibility.

The new concrete subslab was much the same as that replaced, except that the new subslab was supported on a rockfill, which was more compact as the result of settlement. The new slab, for the most part, is in 30-ft. squares, the average thickness is 6 in. (4 in. specified minimum), and spaces 6 in. wide were left between edges of adjacent slabs. These joints, which were thoroughly cleaned out before the timber facing was placed, are expected to relieve pressure from under the timber facing in case of rapidly falling reservoir level as well as to provide enough clearance between slabs to permit of the adjustment that attends settlement.

The timber facing was constructed in lapped arrangement, with planks laid transversely across the face of the dam. After some experiment the best method of construction was found to be the spiking together in the shop of the two lower panels of each three-ply plank unit, adding the third or top plank after the other two were laid in place. The two-plank units were hauled up the face of the dam on dollies Fig. 1.

To secure the required ¼-in. spacing between units along the horizontal joints, roofing tacks were set to protrude ¼ in. from the upper edge of the bottom plank. Thus the edge of the next unit to be placed rested on nail heads in the adjoining unit. The finished surface of the planking and particularly the space between plank edges of adjacent units was treated with asphalt, applied with force-account labor, thus enabling the district to carry out this important feature under its own supervision. Maximum progress in placing the timber facing was at the rate of 50,000 ft. b.m. in two 8-hour shifts.

Untreated timber was used since within the ten-year period that is estimated as its effective lifetime, the dam should have settled practically to final position. If a more substantial facing then should be required, concrete could be used safely.

Additional rockfill

To make sure of the quality of material for the additional fill on the downstream face, the rock was quarried, segregated and delivered to the dam under a separate contract which the district supervised as an entirely separate undertaking. The contract on additional fill included 3,000 cu.yd. of packed rock placed along the crest of the dam and 60,000 cu.yd. of loose rockfill dumped from 25-ft. lifts beginning at El. 2200, or roughly 75 ft. above the toe of the downstream slope. The same contractor quarried, delivered and dumped the rock on the downstream slope in accordance with the specifications, which called for a well-graded mixture of sound angular quarry-run rock, graded approximately as follows: 10 per cent weighing between 100 and 500 lb., 50 per cent weighing between 500 and 3,000 lb., and 40 per cent weighing between 3,000 and 14,000 lb.

The downstream slope, roughly was to be 1½:1 as an average. The variation ranged from a slope as steep, perhaps, as 1.3:1 near the crest to 1.6:1 near the bottom.

The finished top width was 18 ft., and at the center for about 10 ft. in height the upstream face was built up with packed rock placed with its upstream face on a ¼-in. batter. This packed rock parapet reached its maximum height at the center where the camber amounted to 7 ft. That is, it was finished off to a final crest height of El. 2405 at the abutment and El. 2412 at the center.

After the settlement that caused so much damage to the original concrete facing, there was an unsightly curve near the top of the face caused by the relatively greater amount of settlement at that point. The slope at this part

of the face was 1.25:1—rather too steep to make it feasible to trim up the outline with a thin additional layer of rockfill. Hence it was decided to place reinforced-concrete ribs in that area as supports for timber facing that would smooth out the curve of the finished surface. In other words, for about 22 ft. below the parapet at the crest the timber facing is supported on reinforced-concrete ribs 5 ft. apart, which provide a smooth continuation of the upstream-face curve. It is possible that later the space beneath the timber facing and between the ribs will be filled in either with rock or concrete. The slope of the upstream face varies from 1.25:1 at the top to about 1.35:1 near the toe.

When C. H. Howell took over the office of chief engineer in February, 1935, the reconstruction work was well under way. The work was completed under his direction and under the supervision of Paul Baumann, assistant engineer. F. C. McMillan is project engineer for both San Gabriel No. 1 and No. 2 dams, and John A. Herkomer is resident engineer at No. 2.

Contract for reconstruction of the upstream face, held by the Case Construction Co., of Los Angeles, included removal of the old concrete and Gunite slabs, placing the new subslabs, the concrete ribs near the top and the timber facing. This contract was practically completed by the end of April, 1935. The Macco Construction Co., of Los Angeles, held the contract for placing additional rock on the crest and on the downstream face of the dam. This work was finished and accepted April 15, 1935.

Laboratory Determination of Optimum Soil Moisture

Variation of optimum moisture curves with pressure—Determining zero air voids—Laboratory apparatus and procedure

By B. G. Zimmerman
Dept. of Chemical Engineering, University of Texas, Austin, Tex.

THE FACT that there exists a definite but narrow range of moisture content that gives the greatest apparent density for a given method of compaction was presented by R. R. Proctor (*ENR*, Sept. 7, 1933, p. 286) when he applied this theory to the compaction of soils in the construction of rolled-earth dams. This narrow range of moisture content for a given method of compaction may be called the optimum moisture content of a soil.

Since the fundamentals of soil compaction have been discussed by Proctor (*ENR*, Aug. 21, 1933), it will not be necessary to repeat these principles. The primary purpose of this article is to present another satisfactory method for determining the optimum moisture content of any given soil in the laboratory.

Effect of pressure

Pressure is one of the first factors to be taken into consideration. In Figs. 2 and 3, density-moisture content curves are given for three pressures.

Curve 1, Fig. 2, starts with a relatively low density with low moisture content. As the moisture content rises, the density rises rapidly to a maximum value of *A*. Here bulking starts—presumably due to entrapped air—and the density drops, finally to rise again to a new maximum of *B*. This value of *B* represents the optimum moisture content for that particular pressure. From this point on an increase in moisture content is accompanied by a regular drop in density roughly parallel to that obtained in the absence of air. With higher pressures such as those presented by Curves 2 and 3 the effect of entrapped air is much less, as shown by the much smaller drop to a minimum density due to bulking.

The curves in Fig. 3 possess the same characteristics as the curves in Fig. 2, but the maximum compaction for each of the pressures employed is greater than that of the curves in Fig. 2. This is probably due to the differences in the soil types. Sample No. 10, used in plotting the curves in Fig. 2, is a fine sand containing some mica; while Sample No. 4, used in plotting the curves in Fig. 3, is a Texas caliche.

From the curves in Figs. 2 and 3 it can be seen that as the pressure is increased the apparent density of the soil is also increased. However, when the pressure is kept constant, the apparent density increases with the moisture content of the soil until optimum condition is reached. Therefore, the optimum moisture content varies inversely with the pressure; that is, the greater the pressure the lower the optimum moisture content of a soil will be. If the pressure could be increased enough, the peak of the curves or the apparent densities would approach the specific gravity of the soil as a limit, and the moisture content would approach zero as a limit. In other words, should the pressure be great enough to force the soil particles into a solid mass, then the apparent density would be equal to the specific gravity of the soil, and the optimum moisture content would be equal to zero.

From Fig. 3 it can be seen that the optimum moisture change for the caliche, from 250 to 750 lb. per sq.in., is 1.7 per cent, while from 750 to 1,250 lb. per sq.in. it is only 1.2 per cent. In Sample 10 (Fig. 2) the optimum moisture changes are still greater than that of the caliche in Fig. 3. For a pressure change from 250 to 750 lb. per sq.in., the moisture change is 4 per cent, while for a pressure change from 750 to 1,250 lb. per sq.in. it is only 1.4 per cent. Thus, it can be seen that the optimum moisture content varies considerably with changes at the lower pressures, but changes in the percentage of optimum moisture become slight at the higher pressures.

Zero air voids

Before the zero air voids curve can be determined, the specific gravity of the soil must be known. This can be determined accurately by means of a pyknometer in vacuum, using kerosene as the solvent. After the specific gravity is known, the apparent density of the dry soil present in the molded briquette for varying moisture contents at an assumed condition of no air being present may be determined by the equation derived below:

Letting M = weight of dry soil in briquette expressed in grams; V = volume of molded briquette in c.c.; G = specific gravity of soil particles;

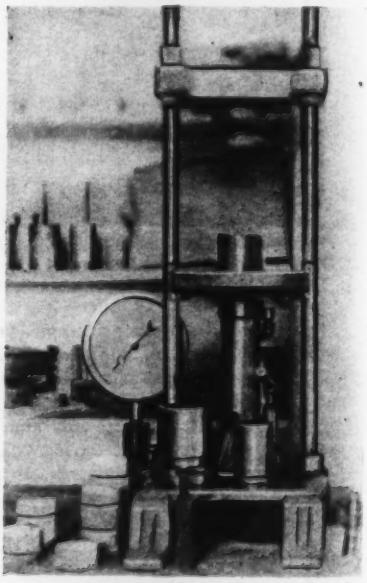


FIG. 1—SOIL BRIQUETTES for optimum moisture tests are molded by hydraulic ram, enabling different compacting pressures.

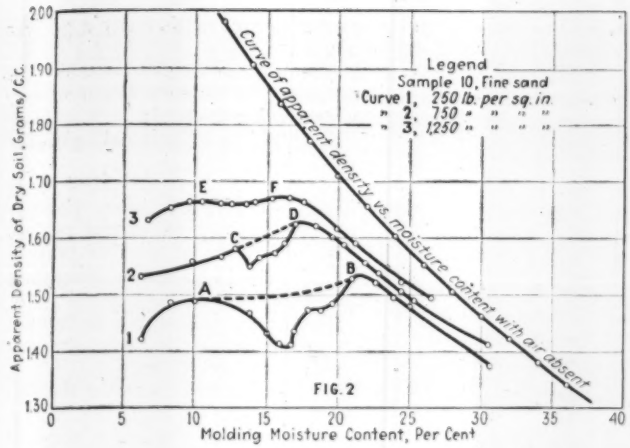

Legend
Sample 10, Fine sand
Curve 1, 250 lb. per sq. in.
" 2, 750 " " " "
" 3, 1250 " " " "
Curve of apparent density vs. moisture content with air absent
Apparent Density of Dry Soil, Grams/C.C.
Molding Moisture Content, Per Cent

FIG. 2

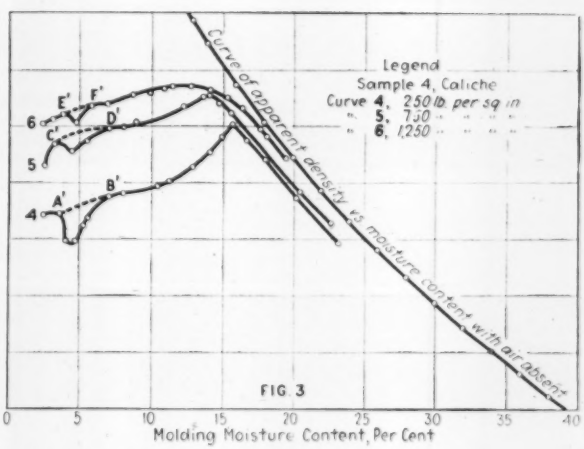

Legend
Sample 4, Caliche
Curve 4, 250 lb. per sq. in.
" 5, 750 " " " "
" 6, 1250 " " " "
Curve of apparent density vs. moisture content with air absent
Molding Moisture Content, Per Cent

FIG. 3

FIGS. 2 and 3—OPTIMUM moisture-content curves for two different soils, showing variation due to compacting pressures employed.

X = moisture content expressed as a fraction of the dry weight of soil; and D = apparent density of dry soil in the briquette:

Since $D = M/V$ (1)

and for any given value of X, $V = MX/1 + M/G = M\ (X + 1/G)$; substituting this value of V in Eq (1), we have

$$D = \frac{M}{M\ (X + 1/G)} = \frac{1}{X + 1/G}$$

Multiplying through by G/G, we have

$$D \text{ apparent} = \frac{G}{GX + G/G} = \frac{G}{GX + 1} = M/V \quad (2)$$

The apparent density of the soil may also be expressed as its dry weight in pounds per cubic foot by means of the following equation:

Wgt. of dry soil (lb. per cu.ft.) = 62.43

$$\left(\frac{G}{GX + 1}\right) = 62.43\ (M/V) \quad (3)$$

Mr. Proctor (*ENR*, Sept. 7, 1933) in his work on the construction of rolled-earth dams expressed the compaction in pounds per cubic foot of the dry soil.

Experimental procedure

Soil samples passing a 40-mesh U. S. standard sieve are being employed to determine the optimum moisture content. Each sample is thoroughly mixed by hand, and then 150-gram fractions are weighed out into small pans. The desired amount of water is added to each fraction and thoroughly mixed with the soil. After the water has been thoroughly mixed with the soil, 150 grams of the moistened material are weighed and placed in a mold. Pressure is applied by means of a hydraulic ram (Fig. 1), and this pressure is held constant for a period of 1 min. Holding the pressure constant for this period insures uniform and maximum compaction of the soil particles at that particular pressure. In some cases, if the moisture content of the soil is too high, water will be pressed out. Should water be pressed out, then the briquette must be weighed after it is molded, and the difference in weight before and after molding is the weight of the water lost. This weight of water, expressed in cubic centimeters, must be added to the volume of the molded briquette to obtain its theoretical volume under molding conditions.

The diameter and height of the briquette are accurately measured, and its molded volume is calculated from these measurements. The measurements are made by means of a caliper accurate to 1/100 in. This volume, expressed in cubic centimeters, corresponds to V in Eq. (2). However, as explained above, if water is pressed out, care must be taken to include its volume in the molding volume of the briquette. A series of such briquettes, possessing different moisture contents, is molded up for each soil sample.

The briquettes then are placed in an oven at 120 deg. C. until constant weight is attained. After the briquettes have attained constant weight, the dry weights are determined accurately to one-tenth of a gram, and these weights correspond to M in Eq. (2).

The amount of water present in each briquette is determined by the difference in weight before and after drying. This difference in weight, divided by the dry weight of the briquette, is the fraction of water present in the briquettes.

The apparent density of the dry soil in each briquette may then be calculated by dividing the mass by the volume as presented in Eq. (2). This actually is the apparent density of the dry soil in the molded briquette. The wet density may be determined by using the molding weight of the briquettes instead of the dry weight, as presented in Eq. (2).

The apparent densities of a series of these briquettes of a soil sample are plotted against their respective moisture contents, and the peak of this curve determines the optimum moisture content of the soil for the particular pressure employed.

City Planners Look to Suburbs as Living Areas of Next Decade

Special Correspondence

A DIAGNOSIS of sick American cities was the subject of a joint conference held in Cincinnati, Ohio, by the four leading planning bodies of this country. Convening May 20 for three days of discussion, the American City Planning Institute, the American Civic Association, the American Society of Planning Officials and the National Conference on City Planning presented a program featuring the subject "What planning can do for the future of American cities." Jacob L. Crane, Jr., president of the Institute named above, concluded, "We are undertaking to rebuild our cities. The cities will not die or disappear. The present many-sided attack on urban housing problems represents the beginning of that reconstruction. To reconstruct, on a reasonably decent basis, the unlivable and uneconomic portions of our bigger cities means at present costs an expenditure of something in the range of fifty billion dollars!"

Suburbs growing

Proof that people are moving to the suburbs of large cities was presented by L. Segoe, consultant to the Ohio State Planning Board. Relating the general population trend to city problems, Mr. Segoe concluded that, ". . . In con-

trast with an increase of 108.5 per cent in urban population during the past 30 years, only 8.4 per cent increase is expected in the next 30 years . . . It is the remarkable growth of the satellite communities and suburban areas rather than that of the large cities themselves that is the most striking phenomenon in the growth of urban communities during the past census decade . . . In all 85 metropolitan districts under one million population . . . the rate of increase in the suburban areas was almost exactly twice that of the central cities."

Engineers for the cities of the future will have to revise their ideas as their clientele changes. Planners think people will want very different places in which to live, work and play. Some factors emphasized at the conference were as follows:

Real estate booms are over except in home building.

There will be fewer new schools, fewer institutions for the care of children, less demand for extensions of waterworks and utility mains.

More institutions for old people, more parks, libraries, museums and art galleries will be ordered.

Greater expenditures will be made for consumption goods and personal services, and there will be a higher standard of living and lower expenditures for capital equipment.

Walter H. Blucher, executive director, American Society of Planning Officials, stated that we in America have learned little about housing since the government entered upon its war housing program seventeen years ago. A federal housing program has been under way two years, and the greater part of the country, he said, has not, to all appearances, learned the elementary principles of housing policy, of which he noted the following: Every slum area is not necessarily an area to be rebuilt with new types of housing. Every blighted area should not of necessity be developed for housing. Cheap land alone will not serve as the only basis for a housing program. No suitable housing program is possible without first having a "land pattern" or a "concept" of the community.

To take our bearings, we must have inventories of every factor in our urban areas, according to A. R. Mann, provost of Cornell University. Land-use surveys are the urgent need, in his opinion. G. D. Hudson spoke for the geography section of the TVA, reporting new techniques developed by geographers which are now available for such tasks as real property inventories and land-use surveys.

Sixty miles of driving showed the delegates the results of planning Cincinnati for a generation. That capital of Ivory soap and building and loan societies, boasts spectacular viaducts and the unique suburb—Mariemont. Unsung are the subway which lies under locked doors, the undisguised iron stacks ventilating comfort stations under Fountain Square, the blocking of proposals to widen Fifth St. by the construction of the Netherlands-Plaza hotel. Defective public relations and impotent city plans blight the city which has done most in America to make city planning famous.

Planning lacks support

Aware of their lack, the planners' program gave time to public relations sermons. But the atmosphere was not that of a camp meeting. Earnest advice for citizens' liaison work met with polite applause. Best received were sallies by Cleveland's Ernest J. Bohn, who showed the dismal failure of planners to "sell" themselves and their ideas to the legislators who have to apportion the public funds. "On the first of January we legislators have to make out the budget," Mr. Bohn said. "We know there will have to be money for all the things the voters want. They want the things they understand, garbage collection, street cleaning and police. But they don't get frenzied over planning even though we know they should. Planners have left the procession behind. So when they ask for money the legislators listen to the voters. If there is a shortage of funds, all services should share according to their merit. But voters don't know what the planners mean to them, so the legislators have to expand the garbage services and pare the planning board to the starvation level."

Glumly, the planners listened while a skilled newspaper editor told them how he had helped their cause. Marshall Dana, long prominent in news publishing and civic affairs in Washington and Oregon, went to the people through daily papers and the schools of the Northwest. Showing why planning was common sense, he emphasized that the question is: How shall we plan? Public enthusiasm demanded that he lead the work as chairman of the second major planning body in the country, the Northwest Regional Plan Commission. (The New England Planning Council is older and deals with a more densely populated region.) Hopeful indications were the casual reports, exchanged in corridors and over the dinner table, of laymen taking spontaneous interest in planning and of adults thronging to popular lectures on city planning in Cleveland. In Chicago, a Metropolitan Housing Council financed by business men is trying to weld planning to vital civic problems. School children trying to plan their home towns were pompously ridiculed by educators puzzling over what to teach planners. Frederic A. Delano, vice-chairman of the National Resources Board, reminisced that the famous Burnham Plan for Chicago had been rewritten into a "reader" and made a standard subject for grammar schools of that city a generation ago.

Resolutions and elections occupied the hours before the farewell dinner session. The conference favored:

A permanent national planning board.

$25,000,000 to $30,000,000 from work-relief funds for planning cities, counties, states and regions.

City planning as part of schemes for clearing slums, rebuilding them as new housing.

A new federal bureau to gather and dispense information on urban conditions and problems.

Election of new officers for the National Conference on City Planning was the occasion for ratifying the proposed merger of that group with the American Civic Association. The new name of the united organization was left for the officers to select. The officers were: Alfred Bettman, president; Charles F. Lewis, vice-president; and Flavel Shurtleff, secretary. The newlyweds will make their home in Washington, D. C.

Climax of the sessions was created by Harold L. Ickes, Secretary of the Interior, when he affirmed that PWA housing policies are aimed to salvage cities and help them readjust themselves to the new era. Engineers in the audience brightened as the secretary announced that the cities must help their reconstruction by providing parks, schools, sewerage and water facilities for PWA housing projects. Determined to make results better and greater than the basic proposals, he announced a national conference of governors and mayors to be held soon, to promote housing projects and city reconstruction.

Low Water Speeds Levee Work On Mississippi River

A total of 1,420,000 cu.yd. of levee work was done in the New Orleans district during April, according to a report from the Mississippi River Commission. By far the greater part of the work during the month was on the Courtableau Dauterive levee in the Atchafalaya Basin, where 816,000 cu.yd. of work was done. A total of 350,000 cu.yd. of work was done on the Lottie-Bayou Long levee, a part of the East Atchafalaya protection levee. Work progressed rapidly at the ring levee at Melville, where 247,000 cu.yd. of material were put in place.

The report also shows that the crest of the spring rise this year was lower than that in any recent year except 1934. The highest water at New Orleans was on May 6, when the gage read 17.31 ft. This compares with the record high mark of 21.27 ft. which was registered on April 25, 1922; with 19.99 ft. in 1929; 19.17 ft. in 1932, and 17.46 ft. in 1933. Last year the highest gage at New Orleans was 12.5 ft.

Danes Introduce New Caisson Practice at Little Belt Bridge

Inventiveness in erecting half a mile of steel spans plays subordinate part to caissons with walls of vertical pipes through which drill bits operate to sink cutting edges after working chamber, built bottom up for floating, is capsized in midstream for sinking

THE INAUGURATION ON MAY 14 of traffic over the Little Belt Bridge in Denmark brings to completion one of the largest bridges of continental Europe and brings to success an unusual caisson-sinking and steel-erection plan. As outlined in *Engineering News-Record*, Oct. 13, 1932, the new bridge provides railway and road connection between the mainland (Jutland) of Denmark and its island of Funen, replacing a ferry that carried yearly some 200,000 passengers and 60,000 tons of freight. The bridge indeed has significance beyond its engineering interest as part of a bridge-construction program of the Danish people to tie up by road and railway the mainland and island parts of their kingdom. At present a second part of the program, the Storstrommen Bridge from Zealand to Falster, which will have a greater length than the Little Belt Bridge, is under construction. The location of the two bridges on the accompanying sketch map leaves possibilities for mainland connection by a bridge over Great Belt from Zealand to Funen or a series of bridges connecting across narrower channels Falster, Laaland, Langeland and Funen. The route if yet determined is not known at this time. Meanwhile the description which follows of the Little Belt Bridge brings us an instructive account of European bridge engineering.

—EDITOR.

FIG. 2—MAP OF DENMARK, showing location of two new bridges now under construction as part of a program to connect the islands of the country to its mainland peninsula of Jutland.

By Prof. Anker Engelund

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THE large new bridge across the sea channel known as the Little Belt in Denmark has interest to the construction engineer because of a novel method of caisson-foundation construction and a successful procedure followed in steel-span erection. Great depths of water up to 130 ft. and clearance of 110 ft. above water add to the interest of both the substructure and the steel-erection operations. In the foundation work, operation in deep water was complicated by currents of 6 to 8 miles an hour, which often change direction. Engineering requirements also made it necessary that the foundation bed should be open for inspection, that possible increase in depth of foundation should be provided, that preferably no concrete should be placed under water, and that no falsework should be used between piers.

Plan developed

At the point of crossing, the Little Belt is 2,700 ft. wide, with depths of water near shores of 65 ft. and of 130 ft. at midchannel. The seabed is a blue-green clay of extraordinarily dense and homogeneous composition; the deeper deposits are absolutely watertight and free from stone, which proved to be of great importance for the success of the foundation method adopted.

Extensive investigations regarding type of foundation, method of erection, esthetic and economic bridge layout, etc., pointed to a high-level five-span cantilever bridge as most suited (see Fig. 3). Proposals to this effect were issued for bidding in May, 1928, terminating on Oct. 1, 1928. Plans and specifications were prepared by the state railways, but bidders were invited to submit alternatives.

By decision of an international committee appointed by the Danish government the contract for the bridge proper with approach spans was awarded to a consolidation of the substructure firms of Monberg & Thorsen, Copenhagen, and Grün & Bilfinger, Mannheim, and the superstructure firms of Fried. Krupp, Rheinhausen, and Louis Eilers, Hannover. The adopted proposal for superstructure and erection was based on the state railways layout, while a method proposed by the contractor was adopted for the foundation.

The planned structure is shown by the several drawings of Fig. 3, except for the approaches. On these, earth embankments, 50 to 60 ft. high, lead up to the approach spans, which are fixed reinforced-concrete arches with four ribs carrying the deck on cross-walls. The Jutland approach has five arches of increasing span and height, the largest being 135 ft. with a height of 80 ft. The Funen approach has three arches of the same type.

Foundation construction

Under the design requirements the allowable pressure on the clay, beyond the existing load of water and earth, was fixed at 11,200 lb. per sq.ft. The adopted design of Monberg & Thorsen, Copenhagen, and Grün & Bilfinger, Mannheim, was based on a skilfully planned caisson method, eliminating compressed air.

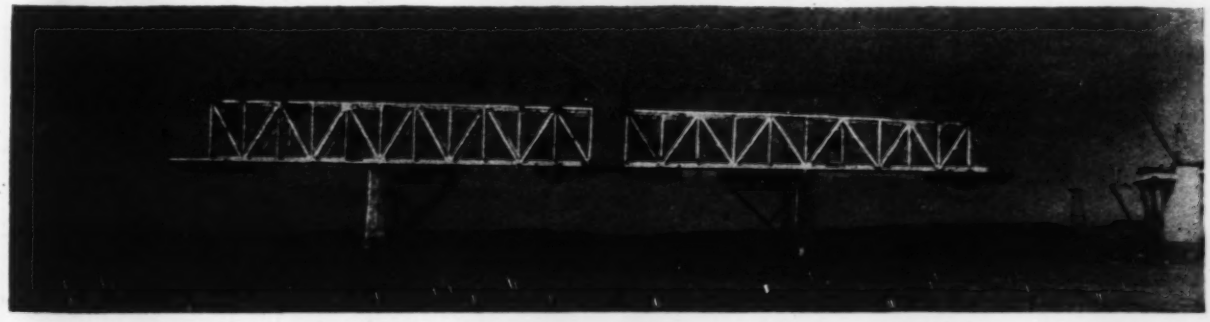
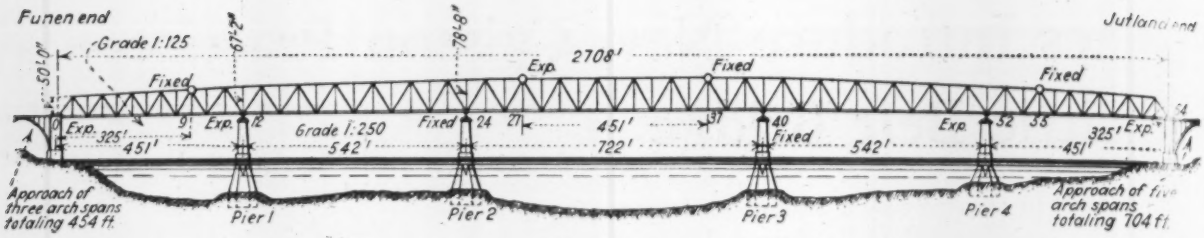
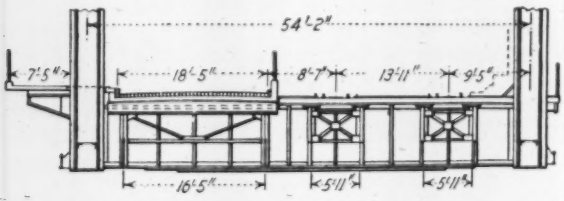
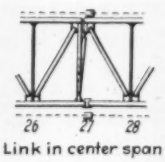


FIG. 1—CLOSING the span between piers 3 and 4 in the half-mile cantilever bridge recently completed across the ocean channel Little Belt in Denmark.







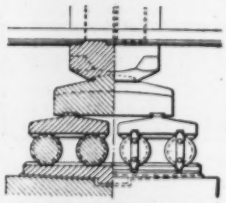

Expansion bearings at pier land 4

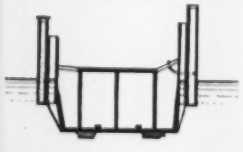
FIG. 3—FIVE cantilever spans, totaling 2,708 ft. for road and railway, complete first link in program to connect islands with Danish mainland.

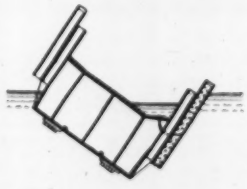
It was proposed to build the caissons with a 23-ft.-high working chamber having a tight wall of riveted steel cylinders 3 ft. 10 in. in diameter. By boring inside these "pipes" through extension pipes reaching above water, the caisson could be lowered 23 ft. into the clay, or until the working chamber roof reached the streambed. The pipes could then be sealed by underwater concreting, the caisson emptied, the working chamber opened and the work completed in the dry without air pressure.

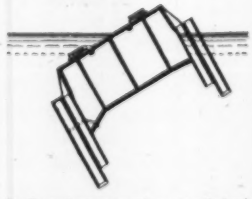
It was originally planned to build the lower part of the caisson of steel on a steel working platform suspended from falsework in the water, and then to float the steel part and build it up of reinforced concrete. On suggestion of the state railways, it was decided to build the entire caisson of reinforced concrete with the encased steel cylinders acting as reinforcement. Also it was considered best to build the first part of the caisson on ways instead of on falsework in the water. Also the state railways required that the caissons should be so constructed, that air pressure could be put on at short notice if necessary.

The planned operation, successfully carried out, is clearly indicated by Fig. 4. The caisson in its first stage

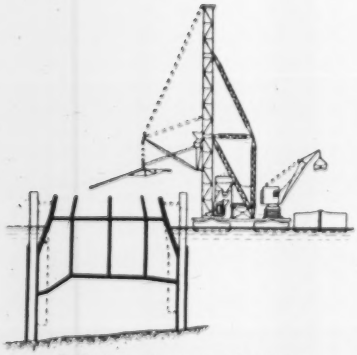
FIG. 4—SEQUENCE of unique process employed in building deep-water caisson foundations for five-span bridge across Little Belt in Denmark.

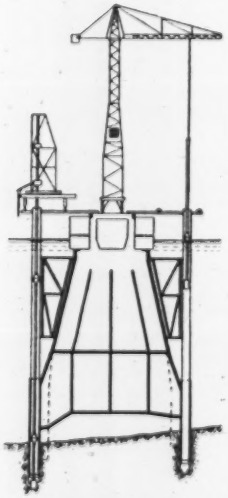

1- Caisson floating upside down after launching. The unsymmetrical wall is balanced by sand during launching

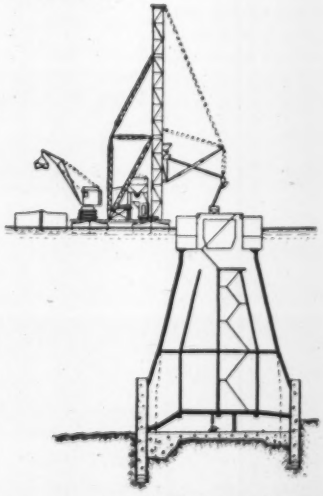

2- Water and stone ballast placed. Caisson ready for turning.

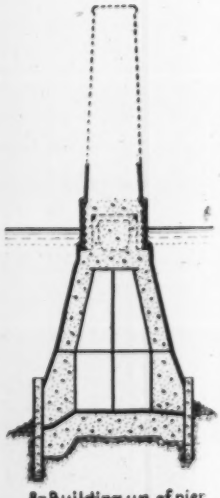

3- Turning nearly completed, stone ballast has fallen out of cylinders.

4- Caisson floating after turning


5- Caisson is being built up in shallow water


6- Caisson is placed in final position and has been sunk by boring in cylinders.


7- Cylinders have been concreted, working chamber emtied and sealing is going on


8- Building up of pier shaft

was cellular with two decks, the lower one being the working-chamber roof. This latter was shaped to conform to the streambed, as was also the bottom profile of the steel cylinders. Considerable strength was required of the 23-ft.-high walls of the working chamber, and several encased pipes inside the wall served as additional reinforcement.

The concrete plant was set up on the Jutland side of the belt with a high distributing tower designed to deliver concrete to approach spans and caissons.

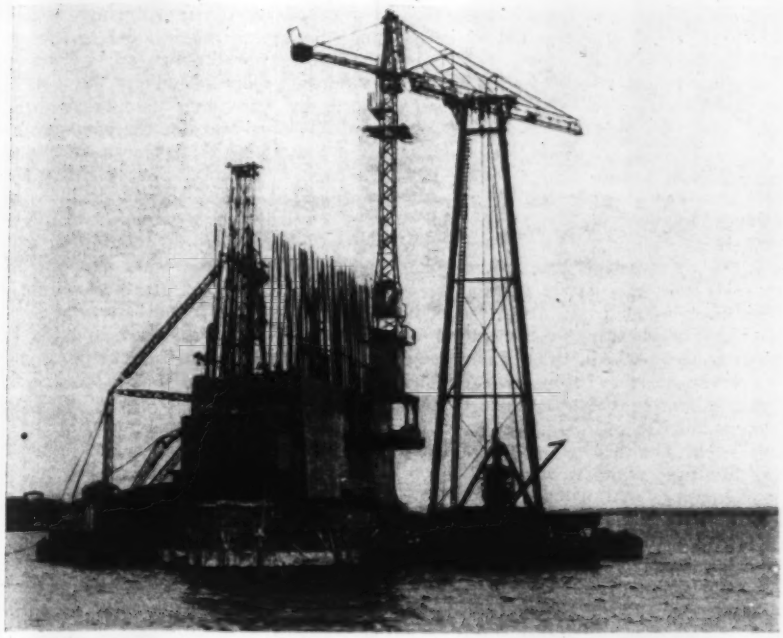


FIG. 5—PIER CONSTRUCTION PLANT employed on Little Belt Bridge in Denmark.

The caisson was built in an inverted position resting on the upper horizontal deck for easier launching. It was supported on sand jacks that were emptied immediately before launching, letting the caisson down on to wooden sledges. The caissons for the three larger piers weighed 7,000 tons when launched.

In the final position the caisson was topped by a reinforced-concrete working platform. Here were placed two portal swing cranes, which placed the extension cylinders reaching from the encased pipes to above water. Two towers with boring equipment traveled on tracks along the cylinder walls. Special drill apparatus was constructed for this work. The material was loosened with water jets and forced up by compressed air. This excavation scheme worked excellently, being interrupted only occasionally when boulders from the upper layers of the soil were encountered. These boulders were taken up by special grab equipment.

When the working-chamber roof had reached the streambed, the pipes were sealed by underwater concreting with dump-bottom buckets of 1-cu.yd. capacity. The working chamber was then opened, and concreting was carried on in the dry after excavating the upper layers of soil. Some cells were left filled with water; otherwise the pier was built solid up to bridge level.

Pier structure and progress

Averaging the records for piers 1, 2 and 3 of corresponding size, dimensions, weight and progress per pier were as follows: streambed, El.—100 ft.; foundation depth, El.—130 ft.; tallest pier, 220 ft.; weight of finished pier, 60,000 tons. Pier weight alone caused a soil pressure of 5,300 lb. per sq.ft.; all dead loads give 6,600 lb. per sq.ft.; maximum allowable pressure for all loads was 11,200 lb. per sq.ft. The base of the pier is 145x73 ft. with rounded corners. The pier shaft is 115x33 ft. at water level and 79x 20 ft. at the top. The launched caisson was 50-60 ft. high, with a weight of 7,000 tons. The final caisson was 120 ft. high. The average time for constructing one pier was two years divided about as follows:

	Months
Work on caisson before launching	5
Finishing caisson and placing it	6
Making caisson ready for boring	3½
Boring and sealing in pipes	2
Work in chamber	1½
Finishing pier and pier shaft	6
Total	24

Steel structure

As shown by the drawing of Fig. 3, the bridge carries a double-track railroad, two highway lanes and a footwalk. The reinforced-concrete roadway slab is supported on secondary cross-beams 7½ ft. on centers, resting on stringers 16 ft. 5 in. apart, which frame into main cross-girders spaced 36 to 45 ft. apart.

The distance from center to center of trusses is 54 ft., and the height of truss varies from 51 to 78 ft. Panel lengths increase from the end to the center of the bridge, so that the diagonals appear nearly parallel. Both flanges have built-up sections, the top flange two channels and a coverplate, and the bottom flange two Z-beams and a coverplate.

The bearings on the two center piers are fixed; all other pier bearings are movable, temperature expansion being taken up only at one of the links in the center span and at the ends of the bridge. The bottom lateral system is a cantilever system like the main trusses, with hinges located at the center line of the bridge, all the hinges being fixed, except at the expansion joint in the center span. The links in the main trusses are shown by Fig. 3. They are all movable, so that the lateral trusses may deflect sideways without restraint, thereby maintaining their assumed cantilever system. The top laterals are arranged in a similar cantilever system, with portals at the piers, but with all hinges of expansion type so as not to restrain the main trusses at the links.

The main shoes all have an upper part resting in spherical bearing contact on a lower part, which in the expansion bearings rests on two or four rollers in a statically determinate arrangement, as shown by Fig 3.

The state railways had specified four possible steel qualities closely corresponding to:

	Lb.
1. British steel 44, min. ult. tensile strength	63,000
2. German steel 48, min. ult. tensile strength	68,000
3. German silicon steel, min. ult. tensile strength	68,000
4. American silicon steel, min. ult. tensile strength	80,000

The successful bidder submitted bids on the three latter steels and proposed as alternative a special German steel, the "Krupp Baustahl." The unit prices for these steels varied from 6.4 to 6.7c. per lb. for steel in place exclusive of painting. It was decided to adopt the Krupp Baustahl, which reduced the amount of steel to a minimum of 13,000 tons. The properties for this steel were:

	Lb. per Sq. In.
Min. ult. tensile strength	77,000
Yield point	51,000
Allowable stresses:	
Dead + live + impact	27,000
Same, plus wind, braking, etc.	32,000
Erection, dead + live	32,000
Erection, dead + live + wind	35,000

Design data

The Little Belt Bridge accommodates a double-track railroad, an 18-ft. 5-in. reinforced-concrete highway and a 7-ft. 5-in. footwalk. The assumed load for each track is a train of two 120-ton diesel engines followed by cars, and for

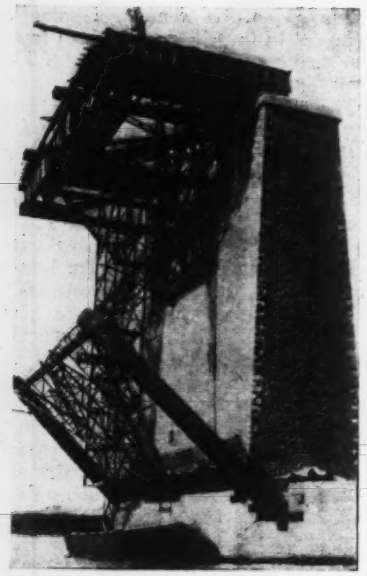


FIG. 6—STARTING the pier brackets used in erecting first panels of cantilever spans for Little Belt Bridge.

the roadway floor a 20-ton steam roller followed by a 20-ton trailer; the main trusses are computed for 102 lb. per sq.ft. of roadway and footway.

Impact is accounted for by the following percentage d of the live load:

$$d = \frac{100}{1 + \frac{n+1}{720}L} \qquad \frac{S_{live}}{S_{live} + S_{dead}}$$

where S is the numerical stress considered, n the number of loaded tracks or highway lanes, and L the loaded length of influence line in feet. The wind loads are: for the loaded bridge 31 lb. per sq.ft., and for the unloaded bridge 51 lb. per sq.ft.

Erection procedure

All the steel was rolled in Germany, where also the major part was fabricated, 3,800 tons being fabricated in Denmark. No punching was allowed for rivet holes, all the holes being drilled. Drilling to full size was allowed for assembled parts, otherwise holes were subdrilled and later reamed. Four panels at a time were assembled in the shop for reaming and matchmarking. Holes for interchangeable parts could be drilled to steel templets.

The trusses were required to stand with a rise of 1/2,000 of each individual opening, when carrying full dead load. The main trusses were laid out in the shop to a cambered curve corresponding to dead-load deflections, so that the members could be assembled without strain or stress.

The steel was transported to the bridge site in pieces weighing up to 25 tons. An assembly yard was established on the Funen side of the Belt, equipped with several overhead running cranes and a 25-ton derrick for unloading the vessels. No shop paint was called for, but at the bridge site the steel was cleansed thoroughly by sand blast and primed twice. Later it received one coat of deck paint.

The erection of the steel commenced in the spring of 1933, when main piers 3 and 4 were ready. The scheme was to support the first panels on erection brackets (Figs. 1 and 6) on one side of each of the piers, and from there to cantilever out on both sides with balanced loads, until the closing of span 3-4 could be effected, thereafter cantilevering farther from pier 4 toward shore and at the same time starting erection at piers 1 and 2, until finally the two halves could be connected by closing span 2-3.

A support was provided near water level on the side of the shaft for a tower crane with overhead swinging arm for use in building up the pier shaft. This crane placed the encased steel in the shaft and erected a derrick on a small bracket half way up the shaft. This latter erected the first part of the steel in the main erection bracket, and on top of this the floor beams and stringers in the first bridge panel (Fig. 6). On this floor steel was next mounted a small derrick, which lifted the lower derrick up to the bridge deck, from where it erected the remainder of the erection bracket and one more panel of floor steel. On this was finally assembled the first main traveler, a portal crane equipped with a main 25-ton derrick and an auxiliary 10-ton derrick. This traveler commenced erecting the truss members to one side of the pier and also assembled a second traveler, which moved out on the other side of the pier, erecting main trusses and floor steel.

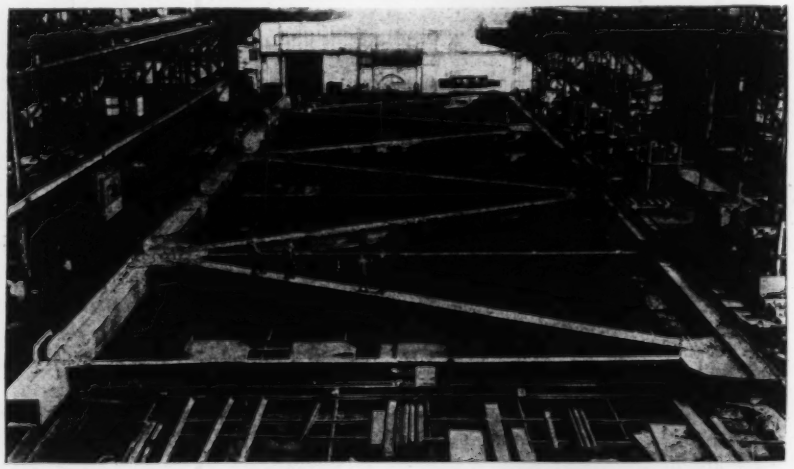
The steel was transferred by barges from the assembly yard to the bridge piers. From here it was hoisted up to special cross-girders cantilevering outside the trusses and was taken transversely along these two trolleys running on the floor steel out to the travelers. A special working platform supported on light trusses cantilevered one panel ahead of the main trusses and moved on the rails for the inspection cars.

The bottom chord in each panel was placed first, carried by a temporary tension diagonal with adjusting means for ease in assembling the remaining members of the panel. About 75 per cent of the holes were required to be filled by bolts and drift pins before riveting.

As already described, the links for the suspended spans are movable, excepting one fixed link in the top lateral system. For cantilever function during erection these links were made fixed in the top chord by tying the two parts together by tension plates, and in the bottom chord by providing temporary cast-steel blocks to transfer the compression stress. Between these blocks were later inserted horizontal jacks for lifting the cantilevered end to correct position before closing the last panel. Further adjustment was made possible by vertical jacking at the truss supports on the erection brackets. In the fixed main bearings on piers 2 and 3 were two bed plates, the upper intended to slide by jacking on the lower for obtaining correct longitudinal position. The trusses erected on piers 1 and 4 were anchored to the erection brackets, as the main bearings on these piers were movable. The truss members in the closing panels were shop-drilled only in one end, the other end being drilled in the assembly yard to fit exactly to the measured gap.

After closing span 3-4, the trusses were cantilevered farther toward the Jutland shore pier, where already two panels had been erected on falsework. These panels were erected in a lower position corresponding to the deflected cantilever end, and after connection with this the whole end span was raised by jacking at the shore pier to allow placing the end bearings.

FIG. 7—SECTION OF MAIN TRUSS of Little Belt Bridge assembled in fabricator's shop for checking before steel was shipped for erection.



At piers 1 and 2 the same erection procedure as above described for piers 3 and 4 was repeated, span 1-2 closed, connection established with the Funen shore pier, and the bridge structure made continuous from shore to shore by the final closing of span 2-3. After this all the links and bearings were brought into their final proper function. During the erection the pier movements were controlled by comparison between actual and computed deflections.

Bids were received on Oct. 1, 1928. A few months later the contract was awarded, but actual work was not begun until the spring of 1930, due to a strike of the workmen. The last caisson for the main piers was placed in March, 1933, and all piers were in general completed by March, 1934.

Erection of the superstructure was begun in the spring of 1933, and the entire bridge with rail and road connections was finished for opening May 14, 1935. A total of 130,000 cu.yd. of concrete went into the four main piers at a total cost of $2,100,000, and 13,000 tons of steel were used in the superstructure, all high-grade steel, at a total cost of $2,550,000. Including $650,000 for approaches and shore piers, the total cost amounted to $5,300,000. The entire work with rail and road connections will cost about $9,000,000.

The consolidation of contractors was represented at the site by the firm of Monberg and Thorsen, Copenhagen. The work of the Danish State Railways was directed by H. Flensborg, chief of the department of ways and works, with the writer in charge of bridge design and supervision.

Cement Macadam Proves Adaptable to Unusual Construction Demands

Two cement-penetrated stone-surfacing operations indicate possibilities of adaptation to reinforcement and joint construction and to highly mechanized construction and also to cruder hand-labor methods

SINCE the recrudescence about three years ago of the old Hassam pavement into modern cement macadam, notable advances have been made in the technique of construction. The earlier cement macadam (*ENR*, Oct. 13, 1932, p. 437) was of comparatively crude workmanship. Each operation that has followed has shown some advance, and the experimental road built in 1933 by the Portland Cement Association developed a knowledge of materials control and construction processes (*ENR*, Feb. 15, 1934, p. 230) that went far toward defining succeeding practice. We have yet a process of construction being developed, as the two articles that follow clearly indicate, and one that approaches stabilization.

Advance has been due, as indicated, to accumulating practical experience and to outstanding experimentation by the cement industry. But another influencing factor and one that is perhaps more nearly fundamental than are others is that a new conception of cement macadam as a road type is being created. Realization is growing that cement macadam is concrete, a concrete inferior to the weight-controlled compositions of selected materials that go into the modern pavement of true concrete, but a material that has the essential properties of cement concrete in surface rigidity and in its reactions to moisture and temperature.

Because of its impliant surface, smothness has to be inherent with construction in cement-macadam roadbuilding; and observation shows that increasing attention is being given to surface finish. Again because expansion and contraction prevail as in true concrete they are being provided for by introducing joints in cement macadam. In control of materials, cement-macadam practice is simulating that of concrete paving. Even the mechanization of construction operations is coming to equal that in concrete paving.

The indication of these changes and the pliancy of cement macadam in meeting them are the important contribution of the two articles that follow.—EDITOR.

Salvaged Sewage Filter Stone for Cement Macadam

By William Whipple
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AT CAMP DIX, N. J., the government was faced with the problem of putting the main thoroughfares of the reservation into condition and of performing the work as a CWA project. The types of pavement that could be considered under these conditions were restricted due to the limited funds available for the purchase of materials. It was planned to employ gravel surfacing on the less-used streets in the cantonment, but a higher-type surfacing was necessary on the heavy-duty thoroughfares in the central portion of the camp. The pavement cross-section decided upon was 20 ft. wide, consisting of two lanes, each lane being 8 in. thick at the edges, tapering to a central thickness of 6 in. in a distance of 2 ft. from each edge. Transverse joints were to be constructed every 50 ft., using premolded joint filler ½ in. thick.

Materials and equipment

A study was made of the local material situation, and it was found that many thousands of tons of trap-rock ballast-size stone were available in an abandoned sewage sprinkling filter bed that had been out of use since the war. On further investigation it developed that this large one-size stone (2½ in.) would be extremely well suited for cement-bound macadam construction, provided suitable fine aggregate could be obtained at small expense. A search

CONTRUCTION SEQUENCE OF A CEMENT MACADAM PAVEMENT FOR A MILITARY CAMP ROAD SYSTEM

(1) Loading stone from old filter bed. (2) Washing stone in job-built washer. (3) Finishing subgrade to templet. (4) Spreading stone by truck. (5) Smoothing and compacting spread stone by templet tamper. (6) Mixing and applying grout binder. (7) Tamping grout-penetrated stone with a templet. (8) Removing metal bulked for installing joint filler.

was made about the reservation for a source of suitable sand supply, and a bank was finally located, which, after tests had been made, proved to meet requirements satisfactorily for grout sand. The only material required for outside purchase, therefore, was cement. After the preparation of estimates, it was found that cement-bound macadam pavement could be constructed within the limit of funds made available under the CWA allotment.

Grading operations were light and were performed almost entirely by a power blade-grader. It was found necessary to wash the stone, and this operation was provided for by erecting a home-made washing plant out of sal-

vaged equipment and other odds and ends. Stone was loaded at the source of supply by a long-boom truck crane. For mixing grout a new ½-cu.yd. concrete mixer was obtained. This was of the end-loading and discharge, self-propelled type, with crawler treads.

Spreading and grouting

Work was started in January, 1934, with experienced foremen but with all other workmen from the county relief lists. Due to cold weather the water was heated by passing it through heating equipment mounted on top of the mixer. Sand was heated by the common method of storing it over an old metal pipe section in which a wood fire was kept burning.

Stone was hauled from supply source to washing plant and thence to roadway, where it was spread by end-dumping into place. The stone was then consolidated with a hand-tamping templet to finished grade elevation, which was a plane section even with the top of the side forms with a 2-in. slope from center to edges. The tamping templet used for this purpose was of 8x10-in. cross-section, steel-shod and equipped with plow handles. During the initial stages of the work, wood side forms were used; later on these were replaced with 8-in. steel forms.

The grout mixer operated outside the area to be grouted, in the adjacent lane, and was batched by wheelbarrows from stockpiles near by. The grout mixture was 1-2 by volume (field basis). A three-bag batch was used that produced about 7.5 cu.ft. of grout. The mixing-water content, including moisture in the sand, amounted to about 7 gal. per sack of cement. The mixing time was 1¼ min. Grout was handled by chute to the pavement area and discharged through the perforated end section of the chute, the discharge holes being 1 in. in diameter and spaced 3 in. apart in each direction.

A standard flow cone was used to establish proper grout consistency, which was established at a fluidity of about 22 sec. flow. Light push brooms were used to control proper grout distribution.

Compacting and finishing

As soon as a sufficient area had been grouted and excess water had disappeared, the entire grouted area was tamped by a tamping templet placed on the pavement in a longitudinal position parallel with the center line and moved transversely across the pavement. The templet was operated by lifting both ends to a height of 6 to 8 in., and then allowing it to drop of its own weight so as to strike the pavement surface at the same instant throughout its entire length. By proper tamping at the right time an even surface was obtained. After the pavement had been tamped longitudinally, the board was used in a transverse position in order that surface irregularities might be eliminated in both directions. Two or more passages of the tamping templet were sufficient to obtain the desired results. No roller compaction was used.

Excess water appearing on the pavement surface was removed by use of a wide strip of burlap manipulated from both sides of the slab. The final finishing was transverse brooming to remove excess grout above the surface on the stone, and also to produce uniform surface texture. The edges and ends of the slabs were tooled to ½-in. radius.

Transverse expansion joints were constructed at intervals of 50 ft. by a method similar to that used in concrete pavement work, using a heavy steel bulkhead made of ¼-in. metal, capped with a 1x1½-in. angle welded to the top edge. The premolded joint filler was inserted under cap against the bulkhead, and the whole installation was securely staked on the subgrade in a position normal to the pavement surface and at right angles to the center line. Stone was then replaced and hand-tamped around the bulkhead. The bulkhead was removed during the same day, leaving the joint filler in proper position.

Summary

A total of approximately 20,000 sq.yd. of cement-bound macadam pavement was completed during the winter and spring months. During this time three classes of labor were used on the job. The work was started with CWA forces, these being replaced largely by new recruits of the Civilian Conservation Corps. Later these men were replaced, and the work was completed by soldier personnel of the First U. S. Engineers.

This pavement has now passed through severe winter conditions in an entirely satisfactory manner, and has proved adequate for the army truck traffic.

The work was started under the direction of Captain R. D. Ingalls and later was taken over and completed by Major T. D. Simkins, assisted by Captain R. Whitaker and the writer.

Intricate Construction Successful with Cement Macadam

By F. W. Stopher
Division Engineer, Ohio Department of Highways, Toledo, Ohio

IN THE FALL of 1934 the Ohio state highway department undertook the experimental construction of a cement-bound macadam pavement, extending south from Camp Perry in Ottawa County, a distance of 4,792 ft. Interesting details of construction were the use of steel-edge and dowel bars in a thickened-edge pavement section; the use of various types of expansion, contraction and longitudinal joints, and the application of standard construction equipment to this special type of construction.

Design or surfacing

Two cross-sections of equal load-carrying capacity were designed, a plain uniform 7-in. section and a thickened-edge section with edge, dowel and center tiebars. This latter was a 8:5.3:8-in. section, the 8 in. tapering to 5.3 in. in 2 ft. The uniform 7-in. section was specified for 3,032 ft., and the 8:5.3:8-in. section for 1,617 ft.

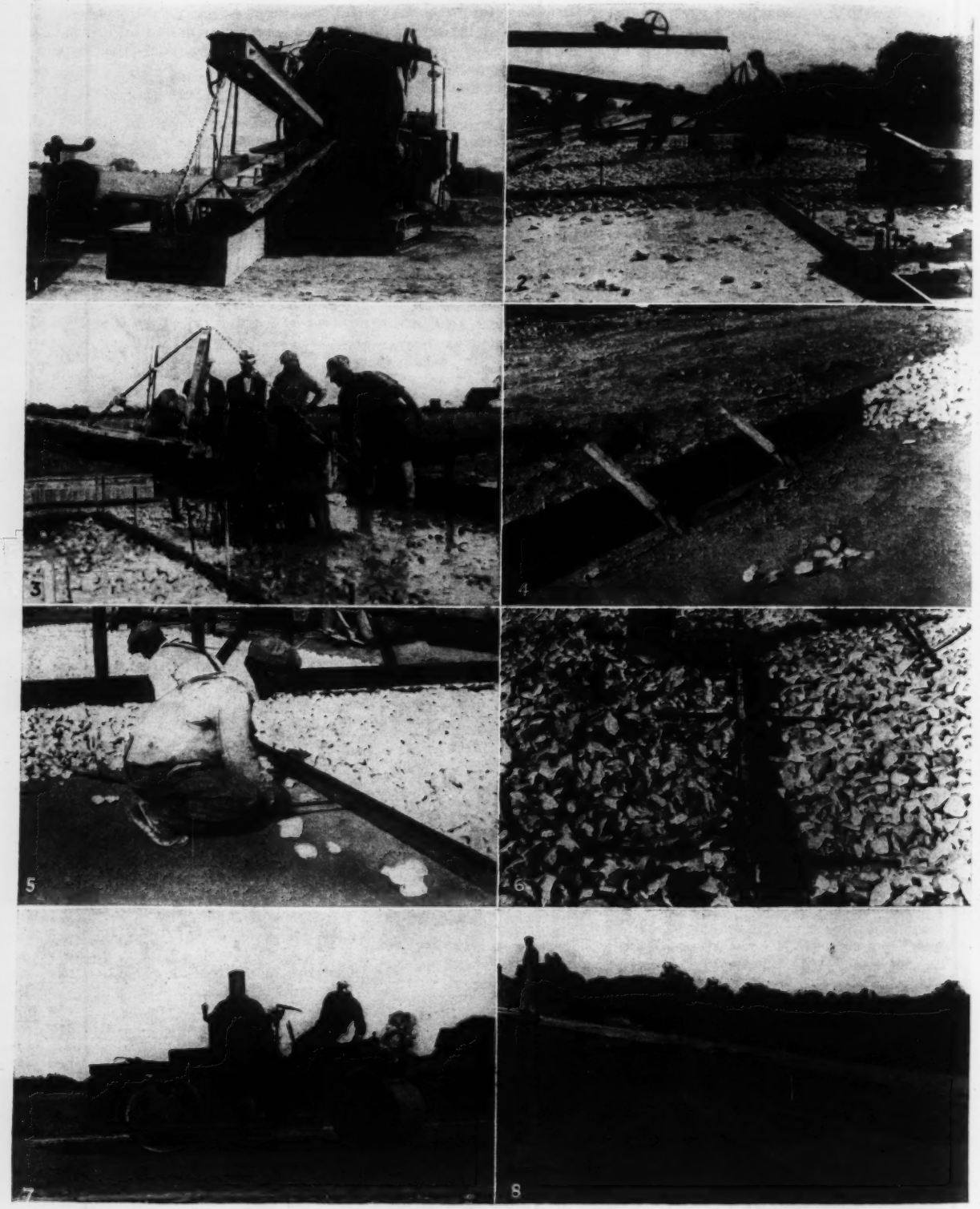
Other design variables included two types (poured and premolded) of 1-in. expansion joints at 160-ft. intervals. The poured joints were used on the uniform 7-in. section, and both the premolded and poured, with dowels, were used on the thickened-edge section. Two types of longitudinal joint were used on the thickened-edge section. Contraction joints were specified at 40-ft. intervals throughout, using inverted wood dummy joints on the 7-in. section and both wood dummy and deformed metal joints on the 8:5.3:8-in. section.

Equipment and construction

The contract for the project was awarded to G. L. LeBoiteaux, of Toledo. The following equipment was placed on the job: One steam crane, one batcher for sand and stone, one 10-ton three-wheel roller for subgrade, one 5-ton tandem roller for rolling grouted stone, one metal stone-spreader box, five 3-ton trucks (average haul ½ mile), one 27-E mixer, one subgrader, one wooden templet, two wooden float bridges with longitudinal tamping templet, three long-handled floats, miscellaneous stone rakes, etc.

The contractor made very effective use of the 27-E mixer by removing the bucket and suspending from the bucket boom a metal drum bottom at the mixer-discharge spout. The metal drum bottom served as a reservoir for grout during discharge and effectively prevented grout spilling. The boom-control gears were disconnected, to permit movement of the boom by the grout-spreading crew.

The project was on level terrain with wide shoulders, which permitted the mixer to travel on the shoulders. The sand and cement trucks likewise used



CONSTRUCTION SEQUENCE OF A CEMENT-MACADAM TRIAL ROAD BUILT IN OHIO.

(1) An efficient grout distributor replacing bucket on 27-E paver. (2) Longitudinal dummy wood joint held in place with steel pins. (3) Strainer head used for even spreading of grout. (4) Edge bars held in place by nails properly spaced in top and bottom of grade stakes. (5) Center-joint tiebars installed after stone was spread on one traffic lane. (6) Transverse expansion joints with dowel bars easily installed after stone was spread. (7) Final rolling produces a quaky concrete, with mortar flushed to the surface. (8) Grouted surface after rolling and before finishing.

the shoulders, thus permitting two-lane grouting without hauling over the stone.

The stone was spread with two trucks by advancing alternately on each traffic lane after the forms and the center joint had been placed. It was then smoothed by hand to the final crown indicated by a wooden templet resting on the side forms. After the stone was spread, it was trenched at intervals specified for transverse joints; the joint material was inserted, and the stone was raked back

Grout was applied the full width of the pavement, followed by rolling with a 5-ton tandem roller, consolidation with a longitudinal tamping templet floating, dragging with burlap, edging and curing, all at the proper intervals.

It was necessary to prohibit initial rolling of the stone previous to grouting due to the softness of the stone being used. This resulted in an increase in the amount of grout necessary to fill the stone voids. If initial rolling is desired, it is essential that the stone be sufficiently hard to resist crushing by the roller.

An old tamping finishing machine was used directly after grouting, tamping and vibrating the freshly grouted stone. It served very effectively in truing out the crown in the grouted stone and replaced in part what might otherwise be accomplished earlier in construction by initial rolling of the stone. It played the greatest part of any piece of equipment used in obtaining a uniform pavement surface on the finished job. This tamper was also very effective in drawing free air and water to the surface, providing a more compact and homogeneous mass. However, it was an improvised machine at the best and not nearly as effective as a machine might be that was designed primarily for such a job.

The average daily run was 325 ft. of 20-ft. pavement in a six-hour day, with a maximum of 641 ft. In view of the fact that the construction was experimental and new to all workers, an average of 100 ft. per hour might well be expected on a well-organized job. On this job an average of 34 men was used in the crew, in addition to the necessary supervision.

Dowels and edge-bars used

The most interesting of the unusual construction details was the method used in installing edge, dowel and center tiebars in the thickened-edge section. This was an entirely new venture, and its successful outcome would permit the use of thickened-edge cross-sections containing less materials with corresponding reductions in cost, which on this initial job was indicated to mean a saving of around $3,000 per mile.

The following procedure proved to be quite simple and satisfactory: grade stakes were leaned against and inside the side forms at an angle of about 45 deg. A nail was driven in the top side at the proper height above the subgrade, to form a chair for the edge bar, and a nail driven in the under side held the stake at the proper angle against the side form. The truck wheels and spreader box cleared the edge bars, and the stone, as spread, rolled under the bar. Although the stone did not spread over the bar, it was easily raked over by hand with no disturbance of the bar. The stakes were then easily turned by hand to free them, and were pulled from the stone without disturbing the edge bar. This procedure produced the desired results very effectively and indicates that standard metal edge-bar chairs would function with equal satisfaction.

The center tiebars were placed after the stone had been spread in one lane by thrusting them by hand through the proper hole in the center steel. The stone offered little resistance to the bars and required only a smart thrust to drive them home. Since the length of the bars caused them to protrude into the wheel track of the portion remaining to be stoned, they were thrust beyond their proper location so that they protruded only about 6 in. Then as the stone truck moved forward they were pulled back to their proper location just before the spreader box reached them.

The placing of transverse joints at 40-ft. intervals was handled easily by two men. They learned that an efficient trenching procedure consisted of first digging down at the forms for a width of the stone forks. Once the subgrade was reached at the form, it was a simple and rapid procedure to fork out the remaining stone.

Other valuable job kinks consisted of carefully backfilling against the forms with earth at all of the joints or other places where grout could leak through them. This left along the forms the grout needed for finishing. In spreading grout, the spreader box was kept in continuous motion to prevent the grout from floating the stone and disturbing the smooth surface left by the stone spreaders. In those cases where the stone was disturbed, the grout was broomed ahead by light brooms, and the surface was smoothed by using the back of the broom to rake the stone to the needed smoothness.

The poured expansion joints worked out effectively by using a wood templet of the required uniform thickness covered with metal and oiled before use. The metal sides prevented the stone from becoming embedded in the templet under rolling, and the oiling permitted easy removal after the pavement had hardened.

Working crew

The average crew was divided among the following principal operations, except subgrading, where the crew varied as the amount of the fine grading varied: one superintendent, one foreman, one steam-crane operator, one steam-crane fireman, one man on plant batcher, two trucks and men hauling stone, two trucks and men hauling sand and cement, three men loading cement into trucks, one man unloading sand and cement trucks, six men spreading stone, two men setting joints, one mixer operator, one man cleaning mixer skip, two men spreading grout, one roller operator, four finishers and one water boy—making a total crew of 30.

In addition, there were from three to fifteen men used on subgrading and helping the form setters. This crew produced the maximum day's run of 1,425 sq.yd., without making any further effort to effect this output.

Production was quite satisfactory when it is considered that the work was entirely new to everyone from the contractor down to the water boy. A longer project or even another short project should give average labor hours close to the maximum production. In general, maximum production on this job was achieved only by the stone trucks and the finishing crew exclusive of rolling. A larger production than was attained on the best day would require more stone trucks and an increase in the finishing crew.

It will be noted that a large crew was used in spreading stone. This was required since the spreader box did not function efficiently and the length of the job did not warrant the construction of a special drag templet back of the spreader or the use of a new spreader. Costs would be cut three men per day on this item. It was also evident that the 5-ton tandem roller could have handled initial stone rolling as well as final rolling, had the hardness of the stone permitted it. The roller was idle more than half the time.

In general, the completed thickness was considerably greater than the required depth due to an excess safety factor introduced in the depth of loose material. As a result, some 4.1 per cent more sand and 12 per cent more stone were used than would have been necessary had the finished depths checked the design depths. Excellent penetration was obtained throughout. Cores drilled from the completed pavement tested at 7 days had an average compressive strength of 2,033 lb., and tested at 28 days had an average compressive strength of 2,001 lb.

State Agencies to Cooperate With Soil Erosion Service

Soil erosion work, recently transferred from the Department of the Interior to the Department of Agriculture, will be conducted in cooperation with state agricultural colleges and other state conservation agencies. Councils composed of five persons will decide the policies to be pursued in each state. The department points out that while the private owner can prevent such things as overgrazing and improper ploughing, essential phases of the problem must be handled by public agencies. Works involving large expenditures are necessary to prevent floods and harmful concentrations of runoff; storage frequently must be provided if water-table levels are to be maintained for urban and other water supply.

Demonstration projects in each state will be continued. CCC forces will continue to take care of local projects. In addition, relief labor will be used on the projects intended to serve large areas.

AN ENGINEER'S RECOLLECTIONS

By JOHN F. STEVENS
Consulting Engineer, Baltimore, Md.

· VII ·

The Great Northern and Jas. J. Hill

As chief engineer of the Great Northern System, Mr. Stevens is given a new insight into the character of that most forceful and interesting figure of a bygone railroad-development era, Jas. J. Hill

MY FIRST personal contact with Jas. J. Hill came in connection with the switchback line over the summit of the Cascade Range (*ENR*, May 23, 1935, p. 749). After I had located it I sent a plan and profile of it to the chief engineer. Shortly afterwards I received a letter from him saying the president, Jas J. Hill, did not like one particular part of my location, and was "coming out to see about it," and directed that no work be done at that particular place. I decided differently.

A few days later Mr. Hill, with the chief engineer and several contractors came over my work. I met the party on the summit. Striding up to me with no further greeting than "Where is that thirteen-degree curve? I don't like it," Mr. Hill looked fairly savage. I said, "Well, that's unfortunate, as the grading is finished, the bridge in, and everything ready for the track." He looked puzzled and said, "I want to see it." So I took the party to a point where they could get a view of the situation. Looking it over, he exclaimed, "That's all right, you could have done nothing else."

The chief engineer seemed surprised—for he evidently expected a vacancy in the roster of his engineers.

I mention this incident as illustrative of Mr. Hill. Nine men out of ten would have vented their displeasure and advanced several better ways of solving the problem, about which they knew nothing, and then would have grudgingly said, "Well, as long as it is done we'll let it go," but that was not his way.

I accompanied the party over the line that day and answered a multitude of questions to the best of my ability. As a sequel, when the monthly pay checks arrived, I found that I had been given a very substantial raise in salary, which the chief was careful to write me had been ordered by the president.

Footloose for a time

During the year 1893 and continuing into '94, the earnings of the Great Northern Ry. were abnormally low, and about the middle of the latter year it became necessary to make drastic reductions in all departments; among other cuts the office of assistant chief engineer was abolished, and I was left footloose. With my family I managed to enjoy the enforced vacation when, late in December, I received a telegram from Mr. Hill asking me to come to St. Paul, which I promptly did, hoping that he had some reconnaissance work for me. On calling upon him he offered me the position of chief engineer of the Great Northern Ry. System, saying that he had decided to make a change in that office. As highly as I felt complimented by the offer, I did not accept it at once, as I wanted to discuss the matter with N. D. Miller, the chief, under whom I had served, and whose ability and personality I respected.

IN THE ISSUE OF MAY 23, Mr. Stevens told of locating a line for the Great Northern Railway over the Cascade Range, and as part of that account he referred briefly to his having been made assistant chief engineer and then chief engineer of the system by Jas. J. Hill soon after the completion of the line. The closer contact with Mr. Hill that came with the new responsibilities gave Mr. Stevens a new insight into the character of the man who had picked him for a key position in his work of extending and improving the Great Northern System. In the following, Mr. Stevens tells of some of his experiences that emphasize Mr. Hill's peculiar genius as a railroad builder. —EDITOR.

Mr. Miller assured me at once that a change was inevitable in any event, and advised me to accept the offer. I therefore apprised Mr. Hill of my acceptance, and on Jan. 1, 1895, I realized an ambition which for years I had cherished but had confided only to my wife, that some day I would become chief engineer of a great railroad. The Great Northern Railway System at that time covered and served eight of the states of the northwest.

Made chief engineer

I entered at once upon the duties of the office, and began the work of a series of years that were the most interesting of my career. They not only covered the longest continuous period of service that I have ever given to any one line of work, but it was the kind of work for which I felt that I was fitted and in which I have taken the greatest interest. While circumstances have led me into other lines which perhaps were more spectacular than those of railway engineering, the latter has always made a stronger appeal to me than any of the others.

While the Great Northern as a whole, from a basic standpoint, was better planned than many of our American railroads, there was much remaining to be done, and many changes and additions were necessary to develop it into the efficient transportation system which it became. I have great satisfaction in knowing that I had an important part in its development.

The decision as to the character and extent of the countless projects required careful study by the chief engineer before they were presented to Mr. Hill, whose edict was final. In all these matters his judgment and farsightedness were preeminent, and he seemed to possess an uncanny faculty of being able to arrive at a conclusion by intuition rather than by intricate calculation. His slogan was full-car loading and heavy trains, and he was the first American railroad executive to equip his road with large-capacity freight cars and what were then considered monster locomotives. These with light gradients and intelligent management were the basic factors that made possible the remarkably low cost of operation, and consequently the unusually favorable revenue from operation of the Great Northern in those past years.

Much new work undertaken

It is unnecessary to attempt to summarize the mileage of the line changes and grade reductions that were made during my time as chief engineer. It was large, but all such improvements were a minor factor in point of numbers of the various classes of works which the engineering department was called upon to plan and execute. Millions of dollars went into the property during the period 1895-1903, and it can

be truly affirmed that much of the Great Northern was rebuilt during that period. The customary authorities based upon engineers' estimates were required for what may be called minor improvements, but not for the many large changes and additions. I do not recall a single instance where Mr. Hill ever called upon me for an estimate of the cost of such works. Many times he would say, "John, you must go ahead and fix up such and such a line," the "fixing up" involving perhaps the building of many miles on an entirely new location about which he knew nothing, but left all to my judgment. He used to say to me, "Don't make a change just to make a change. Make it so some fellow can't come along in a few years and make a change in your work." He wanted the best and was no pinch-penny in these large matters. The system was rapidly expanding, and many miles of new trackage were built in every state covered by it, from Wisconsin to Vancouver, B. C. Enough, I think, to make a fairly large-sized railroad.

The recital of some actual occurrences will illustrate the nature of my contact with Mr. Hill better than could any attempt at a detailed explanation, as in the case of a change of line which cost a lot of money. He came out over the old line in a special and looking across to the new line under construction said, "Look here, you are spending too much money over there," and was seriously disturbed. I said nothing then, but when the train reached a point where the whole situation could be seen at a glance, I stopped it and asked him to take a look. He studied the situation for a few minutes and then exclaimed, "John, if you hadn't done this, I would have fired you. It would have been a crime to have spent money on the old line." And he would have been amply justified in doing that very thing.

A line into the Iron Range

The Lake Superior and Mississippi R.R., built in the early '70s, now the Northern Pacific, climbed the hill to get up from the lake on a heavy grade—later reduced to 1 per cent. The Northern Pacific's original main line west has a comparatively heavy grade up the same hill. The Steel Corporation's line to the Mesaba Iron Range has a 2 per cent gradient. When the Great Northern was ready to build I got busy in finding the right kind of a line up to the plateau summit at about the same elevation as the other lines, none of them having a grade of less than 1 per cent.

It was entirely against Mr. Hill's principles to build any 1 per cent lines other than in semi-mountainous country, and he asked me if I could get an eight-tenths line, to which question I replied that I thought I could and would at once find out, saying that possibly a six-tenths line was there. He cut me off rather sarcastically saying, "You are trying to get sunshine out of cucumbers. An eight-tenths line is very good for that place." I said no more but proceeded at once to try out a plan which I had evolved.

When the final location was completed and maps and profiles were prepared, I took them to him, and told him that I was ready to go ahead and build if he wanted it done. He remarked that he supposed that I had gotten an eight-tenths line, and added a little sarcasm: "How's your cucumber sunshine now?" Glancing at the profile and then studying it intently, he exclaimed, "Why, this is only a four-tenths grade." I could not resist the temptation and remarked, "Oh yes, just a bit of cucumber sunshine." He was very appreciative of what I had done, and ordered me to

Jas. J. Hill

get the work of building the line under contract and push it to completion, which was done. It involved no average heavy grading or bridging nor any appreciable extra length.

The Seattle tunnel

The project of the mile-long tunnel under the business district of Seattle was originated and developed by myself a short time before I left the service of the Great Northern, and it solved a problem that had been under discussion for several years. The situation was very complicated, and several plans, mostly fantastic, had been suggested to relieve it. I said nothing definite until the matter came up for a decision; then I went to Mr. Hill and showed him what I proposed. He studied the plan for a few minutes, and then looking at me rather savagely said, "John, how long have you known of this?" I replied, "For two years or more," and added that as we would have to acquire a lot of land on the tide flats which we did not own, I thought it best to keep it under my hat. For politic reasons I did not tell him how and through whom I feared it might leak out.

He unbent and, looking at me queerly, said "Send for Burke." (Judge Burke was the local attorney for the road in Seattle.) The judge arrived shortly, and at a conference with Mr. Hill and myself said that he thought the necessary ordinance could be gotten from the city. Then Mr. Hill told him to go back and secure, under cover, by purchase or option, the lands which I had indicated, and considerable more which he thought would be needed for terminals, and when he had done so, to wire me and I would go to Seattle and assist him in the matter of getting the ordinance; which I did. We secured the ordinance without much difficulty, and the tunnel was built after I left the road. It is the key to the terminal situation of the Northern lines in Seattle.

It can be readily conceived that these activities kept me fairly busy, but while the few that I have sketched were only a sample of the larger ones, there were innumerable smaller matters to which in the aggregate much of my time was necessarily given. The planning and construction of every addition to or change in the property came under the jurisdiction of the chief engineer, and the sum of them made a total of hundreds yearly, ranging in size and variety from a wooden water trough in a stockyard to the largest locomotive repair shops on the system.

Results count with Hill

Mr. Hill was a rather hard taskmaster in point of time. I often used to wonder how he could expect the completion of a large job in a week or so after he had ordered it done. He kept every one on the jump and not always by suave comments. But it was a pleasure for me to work for him because he was always appreciative of results, although he seldom expressed his satisfaction to me personally, but I usually heard of it through other parties. Sometimes his dissatisfaction did not take such a roundabout channel. But his occasional sarcasms had the same effect upon me as falling water upon a duck's back; he knew it was so, and I think rather liked it.

As a companion he was at his best when going over the road in his special. His vigilant eye missed nothing along the line, and he was an animated interrogation point. At night he was jovial and would tell stories and sing camp-meeting songs as long as anyone would sit up to listen. As I was a target for many of his questions, I learned early to answer them if I knew the correct answer; and if I did not, I told him so, but took occasion to post myself on that particular query.

Resign to get a rest

During the year 1898 I felt the need of a change, for I had been working almost literally day and night for three years. I asked Mr. Hill for a vacation, but did not get it, as he said that I could not be spared at that time. I immediately tendered my resignation, which was accepted after some vigorous comments upon my action, but which concluded by his saying that I would be back inside of a year. Mr. Miller was reappointed and took up the duties of the office of chief engineer again.

I went to British Columbia and took a small interest in a contract to build a heavy piece of mountain railway for the Canadian Pacific, intending to forget engineering for awhile, but I was not allowed to do so. Mr. Hill called upon me from time to time to advise him in engineering matters, and after discussing the subject with Mr. Miller for ethical reasons, I did as he wanted. Finally, at his urgent request, I might say demand, I went back to St. Paul and resumed the office of chief engineer. I had gotten a fine rest during the ten months and had done very well financially. I was given a fine increase in my former salary and a handsome bonus to return to my old position.

After Mr. Hill had bought the stock of the Chicago, Burlington & Quincy R.R., he sent me to make an inspection of its main lines, to report to him as to their general conditions, and especially as to the ability of members of the staff who were then operating the road. I accordingly spent some days on the road with a special train, accompanied by a delegation of its officials.

Manager's job turned down

When I had concluded my observations, Mr. Hill came to Chicago, and with the chief officials we went over two main lines, finally reaching Denver. Shortly after arriving there he offered me the position of general manager of the Burlington, which offer was a great surprise to me, but with little consideration I declined it to his astonishment. I gave two reasons for my refusal, both of which he declined to accept as valid. One was that I had not the experience in handling operation that qualified me for such an important position, and I thought that I best knew my limitations. He brushed that aside, saying that he was a better judge of that than I was.

A second reason was that I thought I had sensed, not exactly antagonism, but a cold feeling among the officials toward any changes in operating methods which might be made if so-called Hill methods were introduced on the Burlington. In fact, I could plainly see a feeling of jealousy apparent among the old Perkins adherents. He countered by saying that he would fire anyone, even the president, who acted against or handicapped me in any way. But I refused to change my decision, and after some heated words he left me abruptly, saying that he didn't care what I did or where I went, and I concluded that my service with him was at an end. I had my car cut out of the train and left for St. Paul via the Union Pacific and Omaha roads. This episode was the only rift that ever occurred in my relations with him, and, as will be seen, it was merely temporary.

On my arrival at St. Paul I immediately began to arrange my work so that I could drop it creditably without giving anyone my reasons. Mr. Hill came back to St. Paul, and to my surprise I heard nothing from him for several days. Finally he sent for me and asked if I still did not want the Burlington management, and when I said no and that I thought my reasons were sound, he said, "Well, maybe you are right," and the matter ended there as far as I was concerned. Then he proceeded to give expression to his poor opinion of some of the Burlington officials, and asked me if I met anyone of them with whom it would be wise to trust the management. He suggested several names, but I maintained a discreet silence in regard to them. Finally, after repeated probing, I told him that I had met one man who seemed alive, who asked me many questions and appeared to want to know something of Great Northern operating methods, and that I thought that man worth a trial before deciding to go outside the road for a general manager. My suggestion of the name did not evoke any enthusiasm on Mr. Hill's part, but a few days later he went over the same ground with me again. Not long after the man whose name I mentioned was placed in charge of the operation of the Burlington, but probably for stronger reasons than I had advanced. That man was the late Howard Elliott.

Made general manager of the G.N.

After settling down again to my work in St. Paul, my fears that my Great Northern service was at an end became gradually allayed, and one day meeting Mr. Hill on the street he stopped me and said, "John, I am having circulars printed making you general manager of the Great Northern. I suppose that you will decline that." I was too astounded to reply. While naturally I was pleased, in some ways I was embarrassed, for I did not particularly want the position. But I felt that I must accept it, and so became general manager on May 1, 1902, retaining also the office of chief engineer.

Here I may relate that some years after I had left the road, I could have been appointed to the highest executive office of that company, but I sidestepped the suggestion as best I could, although it grieved me to do so. I felt that there were and would be certain influences which would handicap me, and to counteract them would require the practice of a diplomacy which I was temperamentally unfit to exercise. While I may have wished that it might be otherwise, I have never regretted my decision, which was made solely for the above reason.

Naturally the duties of the additional office greatly increased my work and responsibilities, although everything went on smoothly, and operating results continued satisfactory. But early in the next year my old restlessness began to assail me and my work did not appeal to me as it had done. I felt moreover, that I had gotten as far as I ever would with Mr. Hill. Perhaps for that reason I imagined that his confidence in me was waning, an idea that was entirely dispelled by his entrusting me with some important confidential investigations and reports several years afterwards, and later in the matter of forcing an entry into Central Oregon for the Northern lines. Certainly no man could be more fully trusted than I was in the control of affairs which he placed in my hands at that time. But, rightly or wrongly, I resigned both offices and went to what I hoped was a larger field.

I think that what I have sketched outlines the story of my work with the Great Northern Ry. and my relations with Mr. Hill during eight strenuous years. These relations were harmonious, and I gained much practical knowledge of railroad and economic matters through them.

Individual judgment wanted

Mr. Hill quickly recognized merit and ability, and neither seniority or rank influenced him in his judgments. Results were what he demanded, and nothing pleased him more than to have an engineer leave the beaten path and find a better way to reach these results. Above all he wanted individual judgment, and no surer path to his disfavor could be found than to endeavor to anticipate his judgment and to recommend accordingly. Taken all in all, to me who understood in some measure the salient features of his perhaps unique personality, and who realized the broad viewpoint from which he regarded every subject, he was an eminently satisfactory man to be associated with. The association was a liberal education to me.

The memory of the last time that we met remains with me. Whenever he came to New York and I was in the city, I always called upon him at once to pay my respects. On this occasion he drifted into reminiscences about the old days, but said nothing about railway matters of the time. As I left his office he came with me to the elevator, something that he never did before, put his hand on my shoulder and said, "John, is there anything in the world that I can do for you?" I replied, "No, Mr. Hill, you have done a lot for me, and I want you to know how deeply I appreciate it." He said, "Well, if there ever is, you know where to find me." I left him then with the sad foreboding that I would never see him again, which proved true, as he passed away some months later, and I took his death as a personal loss. Whatever his attitude may or may not have been toward other men, to me he was always just and considerate, and it is a pleasant retrospect when I recall the many instances where his friendship and guidance were given so freely. The Northwest and the railroad world in general owe much to the memory of a remarkable constructive genius.

Letters to the Editor

The Constant in Jansen's Formula

Sir—Referring to your description (*ENR*, April 25, 1935, p. 598) of Russian large-scale tests for the purpose of determining the value of κ in Jansen's formula, I wish to point out that this, as shown by O. K. Froehlich (*Beton u. Eisen*, Sept. 5, 1934, and Jan. 5, 1935) is not a constant, but depends on the dimensions of the fill. Dr. Froehlich has proven that κ can be determined analytically without the aid of costly and time-consuming tests.

Los Angeles, Calif., May 1, 1935. A FLORIS

Fineness Modulus

Sir—I fully agree with the opinion expressed by F. S. Besson in his article in your issue of Feb. 14, 1935, p. 248, that the fineness modulus does not give a true picture of the material analyzed. I came to this conclusion by the following reasoning:

According to Duff A. Abrams' design of concrete mixtures (Bulletin No. 1 of Lewis Institute) the fineness modulus of the aggregate is the sum of the percentages in the sieve analysis of the aggregate divided by 100. The sieve analysis is determined by using nine sieves from the Tyler standard series. The percentages are those coarser than a given sieve.

If we call x_0 percentage of sample passing the finest sieve (sieve 1); x_k percentage of sample passing sieve $k+1$ and remaining on sieve k; and m the fineness modulus, we have the following:

$$(1) \quad \sum_{k=0}^{k=9} x_k = 100;$$

$$(2) \quad \sum_{k=1}^{k=9} k x_k = 100\, m;$$

$$(3) \quad x_k \geq 0$$

As Mr. Besson already observes, in Eq. (1) for the fineness modulus, the finest particles (x_0) are ignored. Further it is clear that the three equations may be satisfied by an infinity of values for the x's. If the fineness modulus should be 5, this may be obtained by using a uniform material, for which $x_5 = 100$ and all the other x's are 0. The same result is obtained by making $x_1 = x_9 = 50$ and all the others $= 0$, and so on. It is hardly to be believed that two so widely different materials will give a concrete of the same quality.

Now I cannot imagine that a simple reasoning as the above should be unknown to Mr. Abrams, and so I concluded that it was his intention that the use of the fineness modulus should be restricted to certain classes of materials, such as the ordinary types of crushed stone or natural gravel and sand.

But still one might ask, why use an indefinite number as the fineness modulus, when a true picture of the material is given by the simple sieve analysis?

The Hague, Holland, April 20, 1935. P. DEKKER, Adj. Director of Public Works.

Drought and Dust

The following letters apply to conditions as they existed prior to the floods of the past two weeks.—EDITOR.

Sir—Drought conditions in Colorado have changed materially for the better. We have finally gotten rain in the drought-stricken area, spotted to be sure, but practically every section has had some moisture.

Western Colorado continues to receive a generous supply. The area around Denver has been particularly favored, and the city is relieved of its fears of water famine. Northern and northeastern Colorado have had showers, and farmers are busy planting crops. The season is late because planting was delayed until late April and has been held up by occasional rains. The San Luis Valley is still the most favored area east of the mountains and has splendid crop prospects. Southeastern Colorado did not receive rain until the last week or ten days and is still short but has had enough to stop the dust storms, wash the atmosphere and being relief to many people ill with dust-caused ailments. Neighboring states, particularly Wyoming, also are fortunate in receiving rain.

With the coming of rain, the need of wind-erosion control has lessened. The general opinion, as nearly as we can gather, is that the plan proposed to cross-list the blown area received only partial approval by the farmers, and that the amount allotted for this (namely 10c an acre) was wholly inadequate. What we might call the regular projects of erosion control are getting under way.

Fort Collins, Colo., May 8, 1935. CHARLES A. LORY, President, Colorado State Agricultural College.

Sir—In the Oklahoma Panhandle wind erosion is a serious problem to the land, and especially the sandy land in the three counties principally affected. The primary cause is found in the fact that only 8 in. of rain fell in the western county, which is about half the normal rainfall. The wheat planted last fall did not sprout; the wind, blowing as usual, dried out the ground and the fields that were not protected either by sprouted wheat or weeds.

Dust storms started in January and February and have increased in severity and fields affected, progressing from the western end of the Panhandle to and including the western tier of counties in Oklahoma, affecting an area east and west of about 200 miles. The best lands and the lands carefully cultivated have not been affected, the sandy land and the shallow plowed suffering the damage. The wind-erosion project in these three counties started recently contemplates deep listing of the fields as fast as they begin to blow. This brings up the heavy subsoil which will not blow.

The highways that have been graded have not been affected, except to lose the gravel as it is pulverized by traffic. This is speaking particularly for the Oklahoma Panhandle. The state roads were graded to diminish the snow hazard. The same section of road was carried up and down hills with the crown of the road about 1 ft. above the surrounding fields. The sand blows across this road the same as snow. The side ditches are full. Sand is piled behind every weed, shrub and building, but you can travel from one end of the Panhandle, and on all state highways without delay or difficulty. Automobiles are equipped with oil filters in the air intake. Cars without filters will cut out the rings in two days.

There is no alarm felt in the Panhandle as to any permanent damage being done by the wind and, with a normal season, wheat (which is the main crop) will be produced in the same quantities as before. The farmers and operators in the Panhandle will farm to prevent this condition being repeated. Many fields that blew badly in 1933 are not blowing this year.

Oklahoma City, May 9, 1935. WALTER C. BURNHAM, Chief Engineer, Oklahoma Conservation Commission.

Corrections

Sir—In *ENR*, April 18, 1935, p. 571, I note that you have a picture of the causeway connecting Mare Island to the mainland. In a footnote it mentions that the causeway was built by the Bureau of Yards and Docks. I wish to call to your attention that the Bureau of Yards and Docks supervised the construction but that our firm was the general contractor for this project.

San Francisco, Calif., May 10, 1935. H. A. HILP, Barrett & Hilp.

Sir—In checking over the figures in my letter regarding rigid viaduct bents, published in *Engineering News-Record* of May 16, 1935, p. 717, I find that a numerical error has been made. Referring to Fig. 2 in that letter, the values of the coefficients C_3 for all panels should be one-half the values given. All the other figures, including the results, are correct. DANA YOUNG, Connecticut State College.

Storrs, Conn., May 23, 1935.

ENGINEERING NEWS-RECORD

Volume 114, No. 24

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Editorial and Publishing Offices at 330 West 42d Street, New York

June 13, 1935

Construction on Its Own

AS THE SUPREME COURT decision on the NRA recedes into history it is seen more clearly that voluntary action is the straight and only course to industrial self-regulation. Any aid that may be obtained from the Federal Trade Commission and possible laws sanctioning approved agreements within industry will be helpful, but the basic force must be that of the industry itself. Construction interests have recognized this. A meeting of the Construction League next Monday, June 17, to plan for permanent cooperation in carrying forward the movement founded by the construction code, is the expression of the new purpose. It is an open meeting; all who are interested in the industry's betterment are invited. Its outcome should show what degree of voluntary cooperation to stabilize and raise the level of construction can be attained.

Relief Dominates Roadbuilding

APPROVAL of highway projects entitled to relief-works money is to be based on the amount of direct employment provided, says Washington. Specifically, the orders are that projects will be measured on the rate of $1,400 for labor, materials, and incidentals per man per year, and will be selected where relief labor may be used. This means that road construction is to be placed strictly on a relief-labor basis. Argument against the wisdom of this ruling, however cogent, has no purpose. The forces of relief are in the saddle at Washington, and economic recovery has no standing. The obvious task before the highway engineers of the country is to demonstrate that they can accomplish the duty that has been assigned them. It will require far-reaching changes in the programs now tentatively planned and further delay in roadbuilding activities already delayed beyond reason, but the task is possible and should be undertaken with speed and energy. Only in this way, as the conditions now stand, may state highway departments expect to participate in the relief-works program and look forward to utilizing the further $300,000,000 retained for possible future allotment. It is better at once to realize plainly that the struggle in the relief-works highway program is now between the social-welfare-minded groups and the engineers, and that to win the engineers must show that they can create projects able to absorb relief rolls.

No Insuperable Task

TOO GLOOMY A VIEW of the effect on road programs of the relief-works order should be guarded against. The amount of $1,400 expended per year per man employed will, it is true, confine construction to grading and drainage with relief-works funds. But with the end of June the states will have $125,000,000 regular federal aid, which when matched by their own contributions will give them $250,000,000 with no strings attached; this money can be used to surface and finish the roads begun with relief-work funds. A calculation in round figures does not show a situation that is at all discouraging. With 25 per cent reserved for roads off federal and state systems, $150,000,000 remains for main roads. Assuming grading and drainage to make up one-third the total cost, the money required for high-class surfacing and structures to finish the $150,000,000 of grading will be $300,000,000. And the states, if they match federal aid, will have $250,000,000. A replanning of programs to provide for this stage construction opens a way to normal roadbuilding procedure that is reasonably clear.

All Engineers Interested

STATISTICS generally are conceded to be dry, but they also are a very necessary part of our present-day economy. Unless those who would improve the conditions affecting the market for any commodity have fairly complete statistics concerning the commodity before them, they can do little effective planning. The same is true in human affairs—specifically, the engineering profession. If the economic status of the engineering profession is to be studied effectively, accurate statistics concerning it must be compiled. Collection of such statistics has been begun by the U. S. Department of Labor in cooperation with American Engineering Council. Questionnaires have been mailed to the members of all national and local engineering societies within the past few days, also to all recent graduates of engineering schools. But these two groups, large as they are, do not include all engineers as there are many who have never joined engineering societies or who have dropped out, especially in recent years. These men, if they have not received one of the questionnaires, should apply to the Commissioner of Labor Statistics, Department of Labor, Washington, D. C., for a copy. Those who have received the questionnaire should send it in promptly before it is forgotten. Only by making the survey reasonably complete can its value be assured.

Post-Code Construction Costs

FULLER INQUIRY into the effects of code termination as seen by leading contractors reveals that, as we forecast last week, construction costs in all probability will be little affected. One important reason is that the code made no great change in conditions; the advent of the code fifteen months ago found the sharp upturn in costs from the 1932 low tapering off to a stabilized level that was little disturbed by code provisions. Another reason is that construction costs in general have been influenced more by factors outside the code, such as PWA and other governmental regulations. The 30-hour week, prescribed wage scales and the required use of local, inexperienced and relief labor affected public-works costs far more than did code requirements. In fact, most code provisions were nullified at the start by these outside requirements and by lack of compliance cooperation on the part of public agencies. And, lastly, as the construction code was one of the few that contained no price-fixing provisions, it offered no inducements to price raising, and now has no artificial price level to maintain. Basic materials prices, with the exception of lumber, showed little tendency to rise under the codes, and the present stabilized price levels, offering a small but definite profit, are likely to see no great change. Except in certain southern and rural areas, the construc-

tion-code minimum wage rate was already being met. In the excepted areas a slight reduction in costs on projects requiring a large amount of common labor may be looked for. Skilled-labor rates were never controlled by the code, except for isolated cases of area agreements. The consensus of opinion is that construction costs will remain at present levels, or at most decline but slightly.

Back to the CWA

RECENT RULES and decrees issued in Washington limiting relief-works projects virtually to bare-hand operations reveal that the four-billion-dollar program has undergone a profound change since its enactment by Congress early in April. What was then believed to be a public-works system for creating and maintaining employment in depression now turns out to be a magnified copy of the CWA. The harmful effects of the earlier undertaking bid fair to repeat themselves on a scale proportionately larger.

After the five months of time already lost, further loss of time must be faced because of this tardily revealed purpose. From the time the act was proposed, in January, the country has been left in the belief that its part in the relief-works campaign was to plan and prepare projects for its needed normal improvements. Filter plants, grade-crossing eliminations, bridges and subways were among the projects proposed and prepared. None of these can be built under the working regulations decreed within the past fortnight. They cannot be built on a budget of $1,100 per man-year of direct labor, and in any event it would be the height of folly to try to build them by CWA methods. So the time spent up to now in planning projects has been wasted. The blame for this rests squarely on the Washington administration.

When the CWA's $400,000,000 campaign was set in motion, it failed almost at once to bring together a sufficient list of projects. Within three weeks from its beginning the announced intention to do only work of permanent usefulness and to do no work of budgetary kind had to be scrapped, and both waste work of the leaf-raking type and budgetary work, such as building pipe lines for cities, went on the project list. There resulted a demoralizing waste of manpower and much destructive interference with existing employment. Many craftsmen were put out of work because jobs that would have come to them were done by CWA forces free of charge. *Thus, the CWA actually created unemployment.* In addition, it taught cities the unwholesole habit of "getting theirs" from Uncle Sam's purse. The present works program, ten times as large, threatens to produce ten times as destructive effects.

The social-worker spirit of CWA days seems to have become intensified, moreover. Washington reports say that "The program planners don't give a damn about indirect employment." This means that they scorn to consider the *total* of jobs created, which is the only thing that counts, and look only at the number of direct-labor jobs that they can build up from the relief roll. No heed is given to the job-spreading effects of wise investment in the materials and tools needed to build really useful improvements and build them efficiently. Welfare and boondoggling have won out over public works.

That months more will be lost in scheming out a project program is inevitable under the circumstances. Bricks must be made without straw; useful work must be found that can be built with practically no materials or tools, and in immense volume, to keep 3½ million men at work. PWA city projects have little chance of getting very far, for few that are worth while can show a man-year of field labor per $1,100 of cost. Grade-crossing work appears out of the question on the same score. Highway work cannot go beyond grading—and even this must be done by pick-and-shovel methods!—and its results will be useless unless the separate federal-aid moneys are used to provide surfacing. Rural rehabilitation and electric-line building are mere window-dressing, since they offer few job prospects for the unemployed armies of the large cities.

At present outlook the relief decrees appear to throw the hopeful relief-works campaign into utter confusion. And the sense of confusion of purpose is not relieved by such episodes as approval of the Quoddy tide-power project, which has been allotted $10,000,000 for a year's work; the picture of 9,000 men toiling for twelve months breaking rock for this undertaking conjures up visions of the slave armies carved on ancient triumphal tablets. That is not the way to recovery; and it also may not be good relief.

Better Flood Knowledge

VICTIMS of nature's unpredictable whims, the Middle Western states of Nebraska, Kansas and Missouri are this week surveying the damage of their second greatest flood through eyes which only a few weeks ago burned with drought-engendered dust. Of the visible damage approaching the sum of $50,000,000, some is chargeable to the inadequacy of man-made structures, some to the vagaries of chance, some to conditions as yet uncontrollable.

On the brighter side of the picture is the tremendous loss averted by levees which confined the floodwaters, by bridges strong enough to withstand drift and overtopping, by efficient work of the Weather Bureau, the Geological Survey, the state highway departments, the Corps of Engineers, the C.C.C. and the state militia in issuing warnings and evacuating threatened areas. Recording of new flood data is another gain.

Data from the greatest flood on record for the Republican River provide new knowledge of this stream's flood possibilities. No experience was available previously to show that the movement of the crest of the Republican River flood upon Manhattan, Kan., would be swift enough to coincide with the arrival of the Blue River crest at the same point. It was not definitely known that Topeka's levees, built after the 1908 flood, would actually withstand, as they did, a somewhat larger flood. It was uncertain, until last week, whether Kansas City's expensive and much-criticized levee system would protect its homes and industries in a major flood. It was believed until last week that the levees above Lawrence would protect its low-lying sections, but they failed. On the other hand, the latter failure demonstrated that Kansas City's flood crest could be lowered several feet by even such temporary storage.

Thus, much new information on flood action and on the dimensions of structures that will strike the proper balance between adequacy and economy is an offset against the damage done. It is information of high value to the engineer in one of his most difficult and at the same time most useful tasks.

CURRENT NEWS

Road Expenditures Limited in Amount to $1,400 per man

EXPENDITURES for highway and grade crossing work to be made under the relief works act of 1935 must be limited to projects on which not more than $1,400 per man per year is spent for labor, materials and incidentals, according to regulations issued late last week when the certificates apportioning highway and grade crossing funds were sent out to the states. Outside of the highway and grade crossing project the eligibility of work for financing from the relief fund is to be determined on the basis of $1,100 per man per year.

Highway regulations

The regulations for the highway and grade crossing work require that 90 per cent of the persons employed on any project shall be obtained from relief rolls and that all projects will be measured for approval on the basis of $1,400 total expenditure for labor, materials and incidentals per man per year, or, on grade crossing work, on the basis of 40 per cent of the total cost, including cost of property, to go to labor directly employed on the project.

Studies of the Bureau of Public Roads indicate that for a large volume of work carried out under the emergency relief appropriations the cost per man has been $1,700. This indicates at first glance that only secondary roadwork or roadwork requiring an abnormally large amount of hand labor can be carried out under the relief work program. However, the bureau has pointed out to the state highway departments that these limitations apply only to the relief funds, hence the relief funds can be used largely for the first-stage construction of projects on the federal-aid system and for grading and surfacing with local materials on secondary roads, financing the surfacing operations on main roads and other operations where the labor cost is relatively low out of state funds or the regular federal-aid funds.

As the regular federal-aid money amounts to $125,000,000, and as it must be matched with state funds, there should be $250,000,000 to carry out the work of surfacing the main highways that are to be built during the coming year. Though the new provisions will require changes in state programs the Bureau of Public Roads is confident that they all can be adjusted to meet the new conditions.

Grade crossing work

The same regulations apply to grade crossing elimination work, but here the money, exclusive of that required for right-of-way, comes entirely from relief funds.

Projects may be selected without limitation as to location except that not less than 25 per cent of a state's apportionment shall be applied to apportioning with secondary or feeder roads.

Major Somervell Made Executive of Applications Division

Major Brehon B. Somervell, Corps of Engineers, U. S. Army, has been appointed executive officer of the Division of Application and Information, one of the three major divisions of the relief works program. Since his return from Europe where he served as special advisor on a general economic survey of Turkey, Major Somervell has been attached to the office of the Chief of Engineers in Washington.

Lieut. Commander Carl H. Cotter, C.E.C., U. S. Navy, has been named engineering advisor to the divison.

Approved Relief Fund Allotments Now Total Nearly One Billion

Work relief allotments approved by the President to date total $913,767,800. Allotments recommended by Advisory Committee on June 10 (Monday) totaled $59,893,832 including $6,612,800 to Bureau of Yards & Docks of the Navy for 147 projects; $1,215,772 to Army Quartermaster Corps for 23 projects; $25,000,000 to Soil Conservation Service; and $13,827,500 to Forest Service. The balance, which was not itemized, includes allotments to various agencies for administrative expenses and for a small group of non-federal projects which will not be made public unless and until approved by the President.

Two members have been added to the Advisory Committee on Allotments, Julien Harrison Hill, President of State Planters Bank & Trust Co., Richmond, Va., representing American Bankers Association; and George L. Berry, President of International Printing Pressmen, representing organized labor.

Additional Work Financed On Colorado River Aqueduct

Coincident with announcement from Washington that the Reconstruction Finance Corporation have agreed to purchase an additional $36,000,000 worth of bonds of the Metropolitan Water District of Southern California, officials of the district at Los Angeles, Calif., outlined new construction expected to be started with the availability of new funds. The new work will include construction of the 227-mile power transmission line from Boulder Dam to various pumping plants of the Colorado River aqueduct project. This 230,000-volt line will involve an investment of $5,000,000. The power district ultimately will take 36 per cent of the energy generated at Boulder Dam.

The new work to be started includes the five aqueduct pumping plants to be operated by the Boulder Dam energy; the Cajalco Dam for the aqueduct terminal storage reservoir six miles south of Riverside, Calif., and the initial distributing system pipe lines which will deliver water from the terminal reservoir to the member cities of the district.

Relief Works Program Turned to Produce Direct Employment

(Washington Correspondence)

WHILE actual undertaking of the work relief program still is waiting on organization of administrative machinery in the field, the policy that will govern the program has definitely moved away from public works as an instrument of recovery. Although Administrator Ickes states that there is a "reasonable expectation" that non-federal projects may reach the allocation of $900,000,000 made in the law, emphasis will be placed almost entirely on local projects of a work relief character which come up through the district offices of the Works Progress Administration.

Limit set at $1,100 per man

In general the yardstick determining the eligibility of a project will be $1,100 as the cost per man employed. This can very readily be achieved on almost any type of project by placing more men on the payroll than are needed to complete the project within one year, the other principle condition determining its eligibility. Such padding will transfer 3,500,000 men from public relief rolls to public employment rolls which is the only objective that Administrator Hopkins recognizes.

Since the relief works administration was organized, the PWA has submitted to the Division of Applications and Information applications for non-federal projects totaling $67,000,000. Administrator Ickes is hopeful that many non-federal projects will be accepted as coming within the average of $1,100 per man employed by computing this on the amount of money that the federal government puts up. If a municipality applies for a 45 per cent grant and borrows the remainder elsewhere the cost of the project to the federal government, in terms of the number of men employed, obviously will be low and will permit inclusion in the program of many loan-and-grant projects in which the government allots 100 per cent of the cost in the first instance.

The requirements imposed to assure employment of a large number of men do not allow any latitude for federal projects and others which involve heavy engineering construction, although it is believed that if, on reclamation projects for example, the 40 per cent allowance for direct labor was permitted as an alternative to the $1,400 per man limitation on cost, as in grade crossing elimination, such projects could qualify.

Interest rate raised

In order to discourage borrowing from the federal government on non-federal projects, PWA's interest rate, that was cut to 3 per cent on May 24, again has been raised to 4 per cent. It is hoped that by confining applications to the 45 per cent grant that municipalities will raise the remainder elsewhere, thus placing the gov-

ernment in a position where it will get a dollar's worth of work for men on relief rolls out of an expenditure of 45c. from the emergency relief appropriation.

Employment regulations

Regulations prescribed by President Roosevelt this week give preference in employment to persons registered with United States Employment Service and who were on public relief in May. As occupational lists of the labor in this category are exhausted those who subsequently go on relief will be taken care of. With a view to answering the complaint in many places that persons on relief have been reluctant to take jobs in private employment through fear of losing their relief status, those now eligible for employment relief are protected against loss of eligibility if they take temporary employment in private industry or in other public service. Only persons certified for assignment to work by the U. S. Employment Service will be employed on work relief projects but this requirement may be modified by state works progress administrators in connection with any project not operated under contract.

Wages and hours

The wage rates and hours of work set forth in Regulation No. 1 (*ENR*, May 23, p. 756) do not apply to PWA projects. On these the wage rates, subject to the approval of the state PWA directors, shall be determined in accordance with local wage conditions by the authority to which the loan, grant, or allotment is made. On PWA projects begun before the passage of the 1935 act, and on federal projects such as Fort Peck Dam.

On the other hand, the new rates will apply to river and harbor projects, flood control work, and the work of other federal agencies. This applies to such projects as the Passamaquoddy tidal power project in Maine. Administrator Hopkins is authorized to raise or lower the scale for any region by 20 per cent or to make entirely new rates if circumstances may dictate.

Resources study continued

The National Resources Board and the advisory committee established in June, 1934, under authority of NIRA have been abolished and the National Resources Committee has been created by an executive order issued under the relief works act. The personnel and functions of the new committee are the same as those of the old board.

Construction League Acts to Preserve Industry Integration

LEADERS in the construction industry will meet in Washington on June 17 to survey the problems arising from the suspension of the construction code and allied codes, and to translate into an immediately active program the objectives sought through codes, and the activities of the Construction League and other trade associations.

The occasion of the industry gathering is a meeting of the general assembly of the Construction League of the United States which will be held at the Willard Hotel in Washington on June 17, at 10 a.m. The membership of this general assembly is comprised of four representatives from each of the national trade associations which are members of the League, including the American Institute of Architects, the American Society of Civil Engineers, the Associated General Contractors, the National Electrical Contractors Association, and twelve other trade associations in the contracting field, as well as six members in the manufacturing, producing and promotional fields of the industry. The official notice to the representatives of these associations has been supplemented by an open invitation to leaders of the industry, in order that there may be a large and representative attendance in planning the future course of industry integration and development.

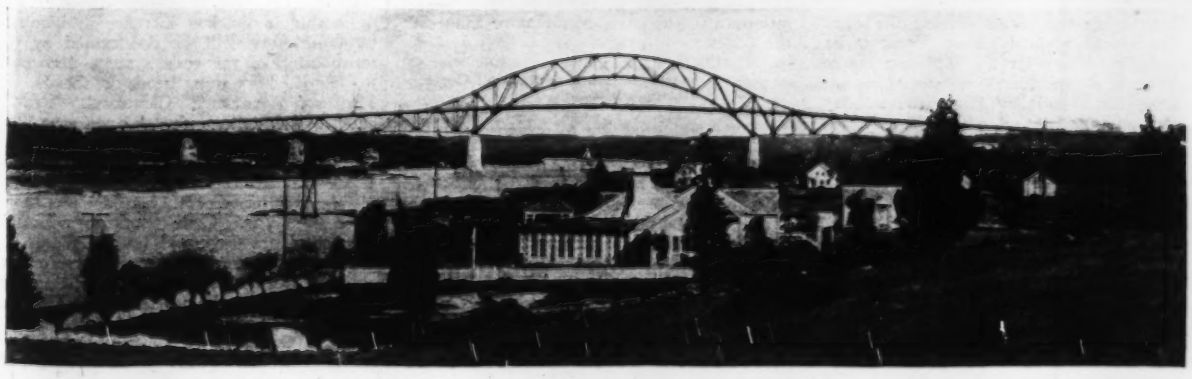
The formal program for the assembly

(Continued on p. 858)

THE MOST BEAUTIFUL STEEL BRIDGES BUILT LAST YEAR

The annual selection of the most beautiful steel bridges erected the previous year in three different price classes, which is sponsored by the American Institute of Steel Construction, was made last week. In Class A, for bridges costing over $1,000,000, the award goes to the Bourne Bridge over the Cape Cod Canal, a structure in which the center arch span and the flanking deck spans comprise a three-span continuous truss. Engineers were Fay, Spofford & Thorndike and fabricators, American Bridge Co. The prize-winning bridge in Class C, for bridges costing less than $250,000, was a deck-arch grade separation structure near Omaha designed by Guy Dorsey, assistant county surveyor of Douglas County. Omaha Steel Works was the fabricator. No award was made in Class B, for medium cost structures, although honorable mention was given to the Woodward Ave. bridge in Detroit carrying the Michigan Central and Grand Trunk Railroads. The Eel River bridge at Smith Point, Humboldt County, Calif., a deck plate girder of four spans, was given honorable mention in Class C.

The jury of award consisted of Dean Frederick Skene, School of Technology, The College of the City of New York; Dean E. R. Bossange, College of Fine Arts, New York University; F. E. Schmitt, Editor, *Engineering News-Record;* Prof. George E. Beggs, Department of Civil Engineering, Princeton University; and Paul P. Cret, Architect, Philadelphia.



meeting has not yet been issued but it is expected to embrace the formation of programs for:

1. Integration (national and state preservation of code gains).
2. Promotion (legislation, administrative contacts).
3. Education (research, publicity, merchandizing).

Reports indicate that trade associations outside the League, as well as those which are members, are looking to the League for leadership, and that several inquiries have been received recently from local groups as to the formation of state construction leagues.

It is believed that the League must be welded into a stronger unit than ever before as the common construction industry medium for legislation, merchandising, basic planning and promotion and preservation of code gains applicable to the entire industry. Suspension of the codes has made it apparent that the construction industry needs coordination and cooperation through a common medium which can speak for the entire industry.

Code Authority meeting

Announcement has been made of a meeting of the executive committee of the Construction Code Authority also on June 17. Other members of the Code Authority have been urged to attend the Construction League meeting to participate in the development of a program for future cooperation.

Reactions from local centers indicate that leaders of the industry, in taking stock of code activities, report an unmistakable awakening of interest in local cooperation and integration among the many groups which comprise the local construction industry. Some local centers report this as the outstanding accomplishment of code operations. Had the codes been continued, unquestionably the most important development would have be .. an emphasis upon local cooperative action, and pooling of resources for administrative activities. Even with the codes gone, local interest in such cooperative action holds forth a promise of immediate gains in local integration under the auspices of the Construction League and its member associations. Within the past two years the League has embarked upon a program of State and local affiliated organizations which would seem to provide a structure upon which to build effective programs of industry cooperation.

New Shield Tunneling Record Made in Driving Midtown Tube

Once again the crews driving the New Jersey shield towards New York under the Hudson River for the Midtown tunnel have made a new tunneling record by advancing the shield 250 ft. in the six-day period ending June 8. This means 100 shoves of the shield and erection of 100 rings of cast iron lining were made in 144 hr., or an average time of 104 min. for a complete shove and erection of a ring. The high 24-hr. run for the week was 18 rings or 45 ft. for the day ending 8 a.m., June 6. The highest week's run on the Holland tunnel, of comparable size, was 150 ft. The New Jersey shield has only 1,600 ft. to go to reach the ventilating shaft caisson near the New York shore line, where it will meet the New York shield.

Contractors Expect Little Change in Construction Costs Due to Codes Ending

THE ENDING of the codes will have little effect on construction costs in the near future, but will probably stimulate private construction, according to opinions expressed by several leading contractors throughout the country at the invitation of this paper. A slight reduction in labor costs may result, according to some of the stated opinions, but the consensus is that very little change is expected. One contractor differs from the rest in expressing fears of a return to old chiseling and bid shopping practices which will result in cheaper bids. The opinions follow:

Highway costs unchanged

Highway construction costs have not been materially affected by collapse of the code as minimum rates and maximum hours are established by state or federal authority. I certainly do not anticipate any decreased cost in highway construction. Material prices are apparently remaining stable up to the present time.

WM. R. SMITH,
The Lane Constr. Corp.,
Meriden, Conn.

Reduction followed by rise

The collapse of the codes will have no effect on construction labor costs because these are influenced so greatly by the efficiency of the men. There may be a possible decrease in general construction costs through the fact that labor in general will understand that it has returned to the merit system and that government protection no longer exists for those who willingly remain inefficient. I believe there will be a temporary decrease in materials costs due to the competitive situation, followed by general recovery and a general increase in prices and costs.

HENRY J. KAISER,
Kaiser Paving Co.,
Oakland, Cal.,

Material prices uncertain

It is our belief that the collapse of the codes will not affect construction costs materially as far as labor costs are concerned. Materials prices are more uncertain, such as lumber, though in this respect factors outside code considerations, such as the West Coast strike, are influencing prices. The codes increased construction costs only in cases of large use of common labor, and likewise will reduce costs only in such cases. The PWA regulations affected costs much more than did the codes.

O. B. CORLENTZ,
Merritt-Chapman & McLean Corp.,
Baltimore, Md.

Bid shopping to return

A Southern contractor, who wishes his name withheld, believes construction costs will decrease because of a gradual return of the old practices of bid shopping, which will drive down material and sub-contract prices. Wage scales will approximate those used on relief rolls. Wages in the South will not reach the pre-code levels because relief agencies will pay a wage that contractors must meet to secure labor at all. However, large operators will not reduce wages or increase working hours to the same extent as will the smaller contractor. A gradual reduction in costs will take place, manifesting itself in about four months. Government work will not be affected, but private work should go for lower prices than obtained under the code.

Rural costs might change

I personally can see no good reason for a material change in trend of construction costs, particularly in metropolitan areas where I believe present hours and wages should and will generally be stabilized. Possibly in rural districts present hours and minimum wages are out of line and there may be changes justified by conditions in these places.

JOHN W. COWPER,
John W. Cowper Co.,
Buffalo, N. Y.

Expect 10 per cent decrease

I anticipate some reduction in construction costs through competitive material prices, but cannot see any appreciable change in labor costs during relief period. I think the trend of construction costs will be downward, and guess at an immediate total reduction of perhaps 10 per cent.

PLATT ROGERS,
Platt Rogers, Inc.,
Pueblo, Colo.

Probable reduction in costs

Experience during the past two years indicates my judgment is of little value. Under NRA, labor costs on public works have increased from 40 to 60 per cent, due mostly to working rules and conditions. Manifestly this same experience of increased labor costs for the manufacturer and producer of materials has increased their cost. With NRA suspended costs will not increase, and probably will decrease. Because only government money is being spent for construction, competition is severe with contractors usually bidding below cost. Contractors cannot bid lower except where costs of labor and materials will decrease bids.

H. P. TREADWAY,
Kansas City Bridge Co.,
Kansas City, Mo.

Private work to resume

The trend toward resumption of industrial construction that has already been noticeable in marked increase in inquiries to contractors will be accelerated by the termination of the code system, according to H. K. Ferguson, head of the H. K. Ferguson Company, Cleveland. Practically all successful industrial concerns have ample liquid resources, and now are reluctant to increase them further. The tendency will be to plow in liquid resources in plant improvement, just as was done after the War. Code abolition will further stimulate the trend toward plant improvement because under newly revived open competition all concerns will find it necessary to put their plant and equipment into best competitive shape.

As to wages, the code had little effect on the building industry, as wages had

always been on a high level and hours relatively low. The code did not change these conditions, and in addition it was subject to much of the chiseling that went on before. Material costs in recent times have had a slight upward tendency. Further advance is improbable but prices in many lines, especially fixed equipment items, will tend to decline. Altogether a gradual but healthy increase in construction volume is in prospect, with no sharp change in costs but a slight downward trend of prices for a time.

Moderate decrease in costs

The chief effect of termination of the code system as seen from the viewpoint of New York construction, according to W. J. Barney of Barney-Ahlers Corp., will be to release a considerable amount of construction that has been deferred. An important factor in holding up a good deal of construction was the psychological attitude of buyers, who felt that under the codes construction costs were excessive and who resented the high level of construction wage rates.

In the metropolitan area specifically, the abolition of NRA is unlikely to have any effect on wages and labor conditions. Over a larger region, especially in rural areas, wage rates will tend to readjust downward from the flat levels set by the code. Materials may be expected to trend downward somewhat, though probably not greatly. The total effect to be anticipated is a gradual and moderate decrease of construction costs as a whole and an increase of volume.

Lower costs possible

Desired and anticipated private construction in the southeast combined with continued Federal work and assistance should assure sufficient employment to cause no downward trend in present construction costs, but on account of the collapse of the code systems there will be a lowering of wage rates on labor producing both materials and construction. Immediate advantage of this lower cost may not be reflected to the owner, and may retard the construction program unless a more liberal construction financing is developed and until the anti-trust laws are revived and made effective against price fixing of basic construction materials.

L. P. SLATTERY,
Slattery & Henry, Inc.,
Greenville, So. Car.

City Planning Fellowship At Harvard University

The graduate school of city planning of Harvard University and the Harvard Traffic Bureau have announced a $1,200 fellowship, given by the Automobile Manufacturing Association, for an approved program of intensive work upon joint problems of city planning and traffic control engineering to be given under the direction of the school of city planning during the school year 1935-36. The competition is open to men in any department of any recognized college or university in the United States who are this spring receiving a bachelor's degree or have received one since January 1, 1933.

Kaw and Missouri Rivers Approached Record Crests in Recent Floods

WITH all streams in the lower Missouri Valley receding after last week's disastrous floods, a review of the situation from Colorado to St. Louis indicates the following significant facts: bridges in the Colorado Springs-Denver area even though built in accordance with best engineering practice washed out in large numbers; Pueblo flood control works received no real test since Arkansas River flood was of small volume; Republican River Valley in southwest Nebraska and north central Kansas suffered greatest flood and largest damage and loss of life in history; Kaw River at Manhattan, Kans., equalled 1903 stage, highest in history, by virtue of Republican and Blue River crests arriving simultaneously; downstream, at Topeka and Lawrence, 1908 crests, second highest in history, were equalled. Kansas City's levee system protected the city completely but was aided by Lawrence levee breaks which cut down crests at Kansas City, and by the fact that Missouri River crest passed some 10 hours before Kaw crest arrived; Missouri River, fed by tributary streams and local rains ran bank full from Kansas City to St. Louis with heavy flooding at Booneville, Jefferson City, Hermann, and St. Charles, near the mouth, where levee failures caused its width to approach five miles.

Kaw flood near record

Not since 1903, have the Kaw River and its tributaries been called upon to carry more water than they did during the week of June 3, 1935, as the accompanying table supplied by S. D. Flora, meteorologist of the U. S. Weather Bureau at Topeka indicates. The 1908 flood was of about equal size. The Marais des Cygnes and Neosho Rivers (not Kaw tributaries) also recorded crests approaching their all-time highs. According to Mr. Flora, conditions were ideal for just such a flood as occurred. The month of May being the wettest month on record in Kansas except May, 1903 and June, 1908. The average rainfall for the eastern third of the state was 10.22 in.; for the central third 8.46 in., and for the western third 4.65 in. The average for the state was 7.78 in., which is 4.01 in. above normal. The average number of days with 0.01 in. or more of rain was 15 which was equalled in May, 1903, but never exceeded. Overflows occurred in almost every river in the state. In commenting on the Republican River flood Mr. Flora says, "The flood, the worst on record for that river, owed its final crest to a great rush of water that crossed the Nebraska line on the night of June 1-2. This crest was maintained as a great wave through the length of the Republican and down the Kansas River past Topeka. It joined with a crest coming out of the Blue River near Manhattan on the night of June 4-5."

J. B. Spiegel, district engineer of the U. S. Geological Survey at Topeka in his report to Washington, copy of which he furnished this journal, comments upon the excellent temporary storage provided by the channels and flood plains of tributaries, which cut down the crests on the main streams. His unchecked computations indicate that at Wamego, west of Topeka, the main channel of the Kaw discharged 107,000 sec.-ft. through an area of about 18,000 sq.ft., with an overflow of some 65,000 sec.-ft. through three bridge spans and four road overflows. At Topeka, where all the water was confined between levees, 148,000 sec.-ft. was discharged through 18,100 sq.ft. of area. Measurements taken from the Santa Fe railroad bridge at Topeka, where there has normally been about 1½ ft. of water, showed 25 ft. on the gage but an actual depth of 43.5 ft., indicating exceptional scour.

Apparently the greatest damage along the Kaw occurred at Manhattan and Lawrence. At Manhattan, unexpected speed of the Republican River crest caused it to arrive coincident with the crest of the Blue River which joins the Kaw at this point. The result was a stage estimated to be

FLOOD STAGES IN KANSAS RIVERS COMPARED WITH PREVIOUS HIGH WATER RECORDS

	Bank full Stage	1935	1903	1908	1915	Other high water marks
Republican River						
Guide Rock, Neb.	11	21.9*	....	....	16.8	
Scandia, Kan.	..	17.8	....	....	14.2	
Concordia	8	15.5*	15.0	....	15.0	
Clay Center	12	25.0	....	....	....	
Solomon River						
Beloit	18	34.5	....	33.2	32.4	33.6 Sept. 20, 1919
Niles	24	29.6	33.8	....	....	25.2 Sept. 26, 1919; 26.7 June 11, 1923
Blue River						
Blue Rapids	18	29.8	36.9	34.0	26.5	24.0 July 7, 1909
Randolph	19	25.4	31.7	30.95	....	
Kaw (Kansas) River						
Ogden	18	....	31.0	....	23.3	18.2 June 10, 1923
Manhattan	17	28*	27.9	24.8	....	
Wamego	16	23.8	26.3	23.0	20.3	17.8 June 29, 1915
Topeka	21	27.6	32.7	28.0	23.8	22.0 May 8, 1930; 42.2 June, 1844
Lawrence	18	22.1	27.0	23.8	21.0	21.5; 1904 date not known
Marais des Cygnes (Osage) River						
Quenemo	30	38.5†	....	....	....	34.6 June 11, 1923; 38.3 Nov. 16-17, 1923
Ottawa	24	32.0†	....	....	....	36.65, 1909; 37.6 Nov. 17, 1928
LaCygne	23	27.1	....	....	....	29.3 Nov. 18, 1928
Neosho River						
LeRoy	18	24.9	....	....	....	29.2 July 5, 1904; 29.6 Sept. 12, 1926
Iola	15	17.4†	22.0	....	....	24.0 July 10, 1904; 22.1 Sept. 13, 1926
Chanute	20	27.8	....	....	....	29.6 Sept. 14, 1926; 26.7 Oct. 3, 1927
Parsons	22	27.4†	....	....	....	27.1 Sept. 17, 1926; 27.45 Apr. 22, 1927
Oswego	17	25.0†	....	....	....	25.2, 1885; 25.4 Apr. 23, 1927

*Estimated. River gage washed out, or reading it was prevented by high water.
†Highest reading reported. May not have been crest but very close to it!

greater than the 1903 flood, and one-third of the houses in this city of 10,000 population and all of its main business district was flooded. Several of the steel trusses of spans of both the state highway bridge and the Rock Island railroad bridge over the Kaw River were washed out.

At Topeka, downstream about 60 miles, levees built after the 1908 flood to hold 32 ft. of water operated efficiently in spite of the fact that the draught had dried them out until their strength was questionable. Overtopping of a levee about 6 miles upstream permitted some of the flood water to pass into an abandoned river channel known as Silver Lake, thus probably saving the lowlands of North Topeka from inundation.

At Lawrence, 25 miles further downstream, two levee breaks flooded the entire area of north Lawrence, occupied by about 500 families. Damage was largely from inundation, the swift running water from the breaks occurring over farmland. All rail traffic on both sides of the river between Kansas City and Topeka was interrupted, railroads affected being the Rock Island, the Union Pacific and the Santa Fe; the U.P. was out of service as far west as Salina.

Kansas City was spared flood damage by virtue of the levee breaks upstream, and the fact that the crest of the Kaw reached the mouth some 10 hours after the crest of the Missouri River had passed. Kansas City's nine-mile levee system, finished 20 years ago at a cost of $1,750,000, confined the Kaw and Missouri within their banks. The Kaw crest at Kansas City was only 21 ft. as compared with 30 ft., which is flood stage. The 21 ft. crest was the highest since the 1915 flood and provided only the second test to which the levees had been subjected.

Captain Orville E. Walsh, district engineer, Kansas City, in a telegraphic review, sets the total area flooded by the Republican, Blue and Kansas Rivers in Kansas, the Missouri River from Rulo, Nebraska, to Hermann, Missouri, (90 miles west of St Louis), and by the Grand, Osage and Gasconade Rivers in Missouri as 1,400 sq.mi. Captain Walsh estimates the damage in Kansas as $5,000,000, and in Missouri from $8,000,000 to $10,000,000. He states that all during the flood excellent data for additional flood control studies were obtained. Also, because both the local agencies and the engineer department were well organized, no lives have been reported lost on the Kansas and Missouri Rivers.

Missouri River damage

Between Kansas City and St. Louis, the Missouri River ran practically bank full, in some cases reaching a width of five miles. In Booneville a crest of 26.7 ft. was reported, flood stage being 21 ft. Other high water marks at this town have been 28.6 ft. in 1909; 28.3 ft. in 1908, and 30.6 ft. in 1903.

Greatest damage apparently occurred in St. Louis and St. Charles counties where the flood hit on June 4. Practically all the bottomland in these counties was flooded as a result of levee breaks. The flood is reported to have been of about the same proportion as that of 1927. A telegram from T. H. Cutler, chief engineer, Missouri highway department stated that advance estimates indicated that about $40,000 would probably cover all highway damages, which consist mainly of washed shoulders and fills, and include the cost of sand bagging, erecting barricades and directing traffic over a wide area. Up to June 8, no major failures had been reported.

MAIN STREET in Manhattan, Kansas, at the height of the Kaw River flood which at this point was estimated to have a crest about equal to the highest on record.

Conditions in Nebraska

A. T. Lobdell, chief, Nebraska bureau of roads and bridges calls attention to the fact that the Republican River has a much larger drainage area than its normal channel would indicate. In general, the divide between the Platte and the Republican rivers is within 10 or 20 miles of the Platte, and this entire drainage area flows into the Republican. After the first rise of the Republican on Friday, May 30, which closed all traffic across the river from May 30 to June 2, there followed local rains which caused some of the tributary streams to rise again. For the five-day period, May 27 to 31 inclusive, weather bureau stations at Elsie, Neb., reported 6.03 in. of rain, at Curtis, 6.32 in., at McCook, 3.53 in., and at Holdredge 5.67 in. The Republican River normally is a stream from 300 to 800 ft. wide, and during the three days' flood it was from 1 to 4 miles in width, flowing entirely across the valley. A. C. Tilley, state engineer of Nebraska, in a wire to the Bureau of Public Roads requested that funds be made available for reconstruction and repair of highways and bridges. Estimates based on field investigations include $400,000 for bridges, $175,000 for highways and $35,000 for detour and temporary bridges. In addition, Mr. Lobdell states that damage to county roads is about $1,250,000. Also that total damages in the valley were between $12,000,000 and $14,000,000.

Colorado floods

With reference to wholesale bridge damage in Colorado Springs-Denver area, Charles D. Vail, state highway engineer wired that "damage has been caused by flood of such unusual and unprecedented character as to wash out bridges built entirely consistent with best economical engineering practice. Repairs will probably all be made on original designs except Pine Creek bridge (*ENR*, June 6, 1935, p. 821), where piers will be omitted."

Information from Arthur Ridgway, chief engineer, Denver & Rio Grande Western R.R., D. P. Gaymon, city engineer of Pueblo, and from Ross R. May of Platte Rogers, Inc., general contractors, indicates that the city of Pueblo suffered no flood damage since the flood in the Arkansas River was of small volume; there was consequently no real test of the flood control works.

The D. & R. G. damage between Palmer Lake and Pueblo was confined to side washes and bridges along Monument Creek and Fountain River, and will not exceed $60,000, according to Mr. Ridgway. Mr. May reports that the Fountain River flow at Pueblo is estimated at from 25,000 to 35,000 sec.-ft.

PWA Extended and Enlarged Under New Executive Order

The functions of the Federal Emergency Administration of Public Works set up under the Recovery Act of 1933, have been extended, enlarged and liberalized under an executive order issued by the President under authority vested in him through the Emergency Relief Appropriation Act of 1935.

Under the new order, the PWA, with Harold L. Ickes as administrator, is authorized to:

1. Continue to perform all functions after June 16 performed prior to that date under the original PWA authority.
2. To make loans and grants to states, territories, possessions, subdivisions and agencies of the government.
3. Carry out projects for slum clearance or low-cost housing, or both.
4. Sell securities required by the PWA and use moneys realized from such sales to make further loans.
5. Acquire by purchase or power of eminent domain, real property and improve, develop, grant, sell, lease or otherwise dispose of such property.
6. Enter into such contracts, and incur such expense as is necessary to perform the functions authorized.

The present executive order also re-allots to departments and agencies of the government any balances unobligated after June 30 from the original PWA funds. Such action will permit continuation of the PWA program without risk of having the funds impounded.

The order permits the PWA to sell securities direct and to use the proceeds for the making of further loans. Initially the PWA was permitted to sell securities it acquired and turn the money over to the Treasury. Subsequently it was permitted to sell securities it had acquired to or through the RFC. Now securities can be sold direct.

Grand Coulee Dam Changed in Design: Power Now Omitted

A CHANGE ORDER under which plans for Grand Coulee Dam are extensively altered was signed June 7 by Secretary of the Interior Ickes. The order calls for construction up to a height of 177 ft. of the complete section for the 475-ft. dam ultimately contemplated. The work now in hand called for construction of a 297-ft. power dam and a permanent cofferdam, both of which eventually would be incorporated into the larger structure. The latter will create a reservoir 150 miles long to store 5,200,000 acre-ft. of water for use in irrigating about 1,200,000 acres of arid lands in the Columbia Basin and installation of power generators with a capacity of 1,890,000 kw. The revised plans abandon immediate power development.

When the Grand Coulee contract was let it was planned to construct a low dam for hydro-electric power production pending the time when the Columbia Basin project should be developed completely. Since then authorization of other power dams in the Pacific Northwest have reduced the need for an immediate power development at Grand Coulee. Another consideration in making the change was that the engineering problems connected with bonding the proposed high dam to the low dam as now being built would be much more serious than those connected with bonding it to the flat foundation surface now planned. Since excavation has been under way, rock slides from the cliffs above the streambed have demonstrated the advisability of completing the full foundation for the high dam immediately to avoid the future necessity of duplicating excavation work.

Work done by the contractors, Silas Mason Company, Inc., Walsh Construction Co., and Atkinson-Kier Co. to date can be utilized fully without waste in construction of the dam now planned. Of the $15,000,000 allotted by PWA for Grand Coulee, nearly $8,000,000 has been spent at the damsite in excavating and other preparations for actual mixing and pouring of the concrete.

The low dam at Grand Coulee would have cost $63,000,000 together with installation of generating equipment. Engineers of the Bureau of Reclamation estimate that the revised plans will call for somewhat less expenditure. While no generating equipment is called for in the new plans foundations will be built for both power houses planned in connection with the proposed high dam. Original plans called for the construction of only one of these power houses.

New Gas Line in Texas

The Lone Star Gas Co., supplying Dallas and a number of other Texas cities with natural gas, has announced that it will build a 20-in. pipeline from the Long Lake and the Cayuga gas field in Anderson County, a distance of 110 miles, to supplement its present supply system. The work is estimated to cost $2,500,000.

Start of Work on Blue Nile Dam And Access Road Still Uncertain

Press reports from Cairo, Egypt, to the effect that work soon would be started under the direction of American engineers on a dam at the outlet of Lake Tsana, at headwaters of the Blue Nile in Africa, and on a highway from Addis Ababa, capital of Ethiopia, to Lake Tsana, have not been confirmed through official channels. For several years past, Egypt and the Anglo-Egyptian Sudan (British interests) have been discussing the question of the division of the water and the sharing of the expense of the Lake Tsana development and of constructing the highway to Addis Ababa, which has been part of the enterprise as discussed with the Emperor of Ethiopia. In 1930 the British interests entered into active negotiations with the Emperor of Ethiopia and since that time the J. G. White Engineering Corp., which according to the report holds the contract for construction of the dam and highway, has confined its activities to survey work and engineering reports on the Lake Tsana region for the several governments at interest.

The J. G. White Engineering Corp. has had no word of the completion of any agreement between the Emperor of Ethiopia and the governments of Egypt and the Sudan.

If, as the Cairo report indicates, the negotiations are under way, it is not expected that they can be completed for several months. At this rate it will be about a year before actual work on the project can be undertaken.

Washington Highlights

BY PAUL WOOTON

Serious consideration is being given in Congressional and executive quarters to a bill by Rep. James A. Shanley, of Connecticut, under which unfair trade practices would be brought under control of the federal government and provision could be made for minimum wages, maximum hours and other conditions of employment.

Elimination of codes has had the effect of increasing the chances of the Guffey coal bill which, in effect, is much like the code but invokes the taxing power with a drawback for those who comply. The land purchase feature of the bill and the quotas for each mine are likely to go out before passage.

It is becoming increasingly apparent that the campaign next year is not going to be a clear-cut fight between radicals and conservatives. The President is expected to throw down the gauntlet to the extreme radicals as well as to the extreme conservatives. In the meantime Mr. Roosevelt will continue to play quarterback and be in charge of all signals.

Steady progress is being made in the regulations of Title II of the Housing Act. An active campaign is getting under way in support of the amendment to Title I, which provides for $50,000 commercial and industrial modernization loans.

WASHINGTON, JUNE 11, 1935.

Contractors Seek To Continue Code Practices

MEETINGS of the Divisional Code Authority for general contractors and of the executive committee of the Associated General Contractors at Washington last week resulted in the conclusion that the code provisions which have benefited the industry should be maintained in effect. As the code authority, which is incorporated, is to be dissolved at an early date, leadership in the movement toward industrial advancement will be taken over by the A.G.C. It was concluded that the construction industry is capable of a larger measure of self-regulation than it has practiced in the past and that the gains made during the fourteen months of code operation should be held with a view to establishing permanently a higher standard of business relationship in contracting.

Practices to be maintained

Special provisions of the code that have been found beneficial and should be maintained in effect by the industry's own action are those relating to receipt of bids, time limit of awards, bid shopping, limits on alternate bids, uniformity of information to bidders, and rebates. Observance of ethical practices with respect to these matters as defined in the code provision is held to be necessary in order that the industry may maintain its status and assure recognition of its integrity and responsibility.

The A.G.C. specificaly urged that the present hours (40) be retained, with an extension to 48 hours for men who are required to work in excess of the minimum in order to maintain the 40-hour week for the crew as a whole. Exceptions should be recognized only in case of remote projects, loss of time from inclement weather or similar delays on remote projects, and work for which a sufficient amount of qualified labor cannot be had. Further, maintenance of the wage minimum of 40c. per hour wherever practicable was advocated, and the A.G.C. recommended that rates of pay be not disturbed, particularly on existing contracts made in contemplation of code requirements. It urged recognition of area agreements formulated under the code, and proposed extending this method of stabilizing labor relations by the establishment of complete schedules in the various areas to provide classification and rates for building, heavy construction and highway work, respectively. After local approval of such schedules they are to be publicized by A.G.C. headquarters.

Code authority to dissolve

The code authority announced that all offices, agencies and committees formed to assist in administering the code are to be closed as of June 15, preparatory to winding up the affairs of the corporation. No registration fees received at Washington after 2 P.M., May 27, have been cashed or utilized but were impounded and will be disposed of as required by law.

Pointing out that unless construction demonstrates its ability to work out its future through industrial cooperation it may experience drastic legislative regulation, the code authority called upon the A.G.C. to preserve the identity of the industry and its objectives in the general interest.

Delays By Others Held No Fault of N.Y. Contractor

NOTWITHSTANDING the usual clause in the contract exonerating the owner "from all damages from delay from any cause whatsoever" a contractor is entitled to claims resulting from delays of other parties when such delay is one not contemplated by either party to the contract, according to a recent decision handed down by the appellate division of the New York State courts. The decision reversed the stand of the court of claims in the case of Afgo Engineering Corp. *vs.* the State of New York.

Decision aids builders

The decision is of interest to contractors because it breaks down one of the barriers used by the state in refusing claims considered legitimate by the contractor. Following is a short résumé of the case:

Afgo Engineering Corp. had the contract for heating work in buildings at Kings Park State Hospital, which were to be constructed by an independent construction contractor. Both contracts were to be completed on the same day. The Afgo contract required the furnishing of temporary heat during the period from October to May. Had both contractors completed according to the terms of their contracts the temporary heat period would not have been reached before the work was completed, but the construction contractor encountered financial difficulties and at the theoretical completion date its work was virtually at a standstill. At the same time the work of the Afgo Company was 93 per cent complete, but it could not be fully completed until the construction contractor had finished. The state finally cancelled the contract of the construction contractor and relet the uncompleted work to a second contractor, thereby extending the time for completion ten months beyond the original specified time. The second contractor likewise encountered financial difficulties. As a result of the two construction contractor defaults, Afgo was compelled to furnish temporary heat over two winters beyond its theoretical completion date and claimed the cost from the state as an extra. The state defended on the ground that Afgo's damage was caused through delay and that by express provision in the contract, Afgo had exonerated the state from all damages from delay from any cause whatever.

Lower court reversed

The case was tried in the court of claims, Afgo contending that notwithstanding the delay waiver in its contract, this particular delay was one not contemplated by the parties, and the reletting to the second contractor with an extended completion date constituted an active interference with the work of Afgo. The court of claims dismissed the suit brought by the Afgo Company because of the clause freeing the owner from damages caused by delay but the appellate division, when the decision was appealed, reversed the lower court and awarded judgment to Afgo for the full amount of the damages it claimed in its suit. The Appellate Division upheld the contention that the contractor was not responsible for the delay.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, annual mid-summer meeting, Toronto, Ont., Canada, June 17-19.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Los Angeles, July 3-5.

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, summer meeting, Ocean City, N. J., July 11-13.

INSTITUTE OF TRAFFIC ENGINEERS, sixth annual meeting at Louisville, Ky., October 15-16.

PENNSYLVANIA SEWAGE WORKS ASSOCIATION, annual meeting, State College, Pa., June 24-26.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

THE ENGINEERING SOCIETIES OF NEW ENGLAND elected the following officers: Chairman, George A. Montague; vice-chairmen, Harold K. Barrows and Frederick W. Bliss; treasurer, Leon F. Jackson, and Clerk, Holcombe J. Brown. Members of the executive committee, Kenneth D. Hamilton, Arthur W. Dean and Chester A. Corney.

Personals

CLARENCE MACCULLUM has been appointed supervising engineer for survey of the sewers in Nassau county, N. Y.

RAY CRITTENDEN has been promoted as administrative assistant to James W. Bradner, Jr., town manager of Norris, Tenn.

JAMES H. GRAHAM, of Louisville, Ky., an alumnus of the University of Kentucky, has been appointed dean of its Colege of Engineering, to fill the vacancy caused by the death of F. Paul Anderson.

CAPTAIN H. J. CASEY, Corps of Engineers, U. S. Army, has been appointed assistant to the district engineer on the Passamaquoddy power project at Eastport, Me.

STEPHEN F. VOORHEES, chairman of the Construction Code Authority until its nullification, was elected president of the American Institute of Architects, at the recent meeting of the institute.

LIEUT. COMDR. WILLARD A. POLLARD, JR., Civil Engineer Corps, U. S. Navy, has been ordered from duty at the Army Industrial College, Washington, to the Bureau of Yards and Docks, Navy Department, Washington.

CAPT. PATRICK H. TANSEY, Corps of Engineers, U. S. Army, Assistant PWA Administrator for Hawaii and chief of operations, U. S. Engineer District, Honolulu, has been ordered to the General Staff School, Ft. Leavenworth, Kan.

WALTER KIDDE, president, Walter Kidde Constructors, New York, and chairman of the board of trustees of Stevens Institute of Technology, was awarded the degree of doctor of engineering by the Institute at its 63rd annual commencement.

NORMAN H. GUNDRUM, office engineer for the Illinois state highway department at East St. Louis, has been transferred to the main office of the division of highways at Springfield, Ill., to be assistant engineer in the construction division of the maintenance department. Mr. Gundrum has been in the highway department since 1920.

FELIX GUENTHER, JR., has been appointed chief engineer of the Pennsylvania Dixie Cement Corp., with headquarters at Nazareth, Pa. Mr. Guenther is a graduate of Case School of Applied Science. NORMAN V. GEYER succeeds him as superintendent of Plant No. 1 at Kingsport, Tenn.

GEORGE W. MALONE, state engineer and member of the Public Service Commission of Nevada, has resigned from those positions to devote his full time to consulting engineering practice. He is a member of the firm of King & Malone, consulting engineers, San Francisco, Reno, and Washington, D. C.

ANDREW F. ALLEN, district sanitary engineer for the New York state health department, Buffalo, N. Y., for the last four years, has been promoted to the head of the new bureau of camp sanitation at Albany. RALPH B. BATES, state sanitary engineer for the Hornell district, will replace Mr. Allen at Buffalo.

FRANCIS BLOSSOM, an engineer associated with Sanderson & Porter, engineers and contractors of New York, has been appointed a trustee of Columbia University. Mr. Blossom, who graduated from Columbia in 1891, has been with Sanderson & Porter since 1899, specializing in railway, light and power developments.

LIEUTENANTS WILLIAM WESANEN and A. S. C. WADSWORTH, Civil Engineer Corps, U. S. Navy, have been detached from duty at Rensselaer Polytechnic Institute, Troy, N. Y. Lieut. Wesanen goes to the Naval Operating Base, San Diego, and Lieut. Wadsworth to the Naval Air Station, Pensacola, Fla.

RUSSELL H. PEDIGO, who has been employed by the St. Francis Levee District of Arkansas for the past year and a half as resident engineer in charge of the purchase of right of way for the reconstruction, enlargement and set-back of 160 miles of levees has been appointed chief engineer of the Bogue Phalia and Riverside drainage districts of Washington County, Mississippi. The offices of Mr. Pedigo will be Greenville, Miss.

DANIEL E. MORAN, consulting engineer of New York, has been awarded the Class of 1889 Medal, Columbia University. The prize, which was established in 1915, is awarded to graduates of the School of Mines, Engineering, or Architecture for distinguished contributions in any sphere. Mr. Moran was graduated from the College of Engineering in 1884.

ARTHUR F. COMSTOCK has resigned his position as chief estimator of James Stewart & Co., building contractors, New York City. Mr. Comstock, a graduate of the University of Illinois, and formerly with John Gill & Sons, Cleveland, had held his position for the past six years.

J. F. LABOON, member of Chester, Laboon, Campbell, Davis and Bankson, has taken an indefinite leave of absence from the firm to become director of the works division for Allegheny county, Pa. Under the new program the labor load will be increased from the present 7,000 to 30,000

with a corresponding increase in expenditures. On May 22 Mr. Laboon was elected trustee of the Carnegie Institute Board.

HARRY N. PHARR, Memphis, Tenn., levee engineer, has been named a member of the Mississippi River Commission. He has been identified with levee building in the St. Francis district several years. He succeeds the late C. H. West, of Greenville, Miss.

CAPT. C. W. BURLIN, Corps of Engineers, U. S. Army, has been ordered to Philadelphia, Pa., as assistant to the district engineer, effective upon his arrival from Panama. CAPT. W. E. HARRIS has been transferred from Norfolk, Va., to Sacramento, Calif., as assistant to the district engineer, and CAPT. E. P. KETCHUM, immediately upon his arrival from Panama, will be sent to St. Louis as assistant to the district engineer.

Obituary

O. E. ARGO, city engineer, of Caruthersville, Mo., died at Memphis, Tenn., on May 24, at the age of 58 years.

STUART MANNELL, 58, a Seattle civil engineer, died in Seattle on May 14. Mr. Mannell was an active member of the Seattle Engineers' Club.

GEORGE A. SUTER, former president of G. A. Suter & Co., New York, died on May 30 at his home in New Canaan, Conn., at the age of 72. Mr. Suter graduated from the Columbia School of Mines in 1883 and specialized largely in building work.

CHARLES ALFRED WILSON, consulting engineer, Cincinnati Union Terminal Co., former chief engineer of the Wheeling and Lake Erie Ry., died at Cincinnati on June 3, in his 80th year. Mr. Wilson was one of the founders of the American Railway Engineering Association and has been active in its affairs for more than 35 years.

G. EMERSON GILLEY, member of the Pacific Coast building supply firm of Gilley Bros., Ltd., died recently at New Westminster, B. C., aged 62 years.

EDWARD PARRISH, a retired civil engineer, who was at one time chief engineer of the Newport, R. I., district under the jurisdiction of the U. S. Engineer Corps, and for many years an authority on river and harbor development, died at his home in Newport on June 9. He was born in Philadelphia, Pa., 86 years ago, and at one time was a professor at Swarthmore College.

CONSTRUCTION STATISTICS OF THE WEEK

HIGH private awards at $12,961,000 raised this week's volume of engineering construction to $26,285,000, compared with $19,672,000 last week. This is the fourth time this year that private construction has passed the $10,000,000 mark. Public projects totaled $13,324,000, of which $10,889,000 represents state and municipal and $2,435,000 federal.

The largest increases in awards for the week are in industrial buildings at $6,535,000 and commercial buildings at $5,783,000. There is an increase in public buildings at $4,763,000, streets and roads at $3,852,000 and earthwork and waterways at $1,731,000.

The larger projects include a paper mill at Savannah, Ga., for the Union Bag & Paper Co., $4,000,000; packing plant at Chicago, Ill., for Armour & Co., $1,000,000; apartment house at Brooklyn, N. Y., $500,000; housing project at Meadville, Pa., $1,000,000; completing college buildings at Cleveland, O., for John Carroll University, $500,000; county home and hospital at Woodville, Pa., for Allegheny County, $2,283,000; county home at Eastview, N. Y., for Board of Supervisors of Westchester County, $1,000,000. Highway awards by Illinois total $588,000. At Minneapolis, Minn., Contracts 305-A, 306-B and 311-C of the intercepting sewerage system will be put under work by day labor estimated to cost $586,000. At Yuma, Ariz., the Bureau of Reclamation let contracts for dredging in All-American Canal, Schedules 1, 2, 3 and 4, $766,000, and in Utah for constructing Ogden-Brigham Tunnel and 30,000 ft. 72-in. wood stave pipe line, $478,000; Delaware River Joint Commission awarded contract 10-A for block signalling equipment for high speed rail transit line across Delaware River between New Jersey and Pennsylvania.

State and municipal bonds sales totaled $2,610,000. There were no PWA allotments for either federal or non-federal work.

CONTRACTS
(Thousands of Dollars)

	Weekly Average June 1934	Prev. 4 Weeks	Week June 13 1935
Federal Government	$5,624	$4,568	$2,435
State and municipal	17,343	11,563	10,889
Total public	$22,967	$16,131	$13,324
Total private	4,531	10,543	12,961
Week's total	$27,498	$26,674	$26,285

Cumulative to date:
1934...$662,196,000 1935...$593,067,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

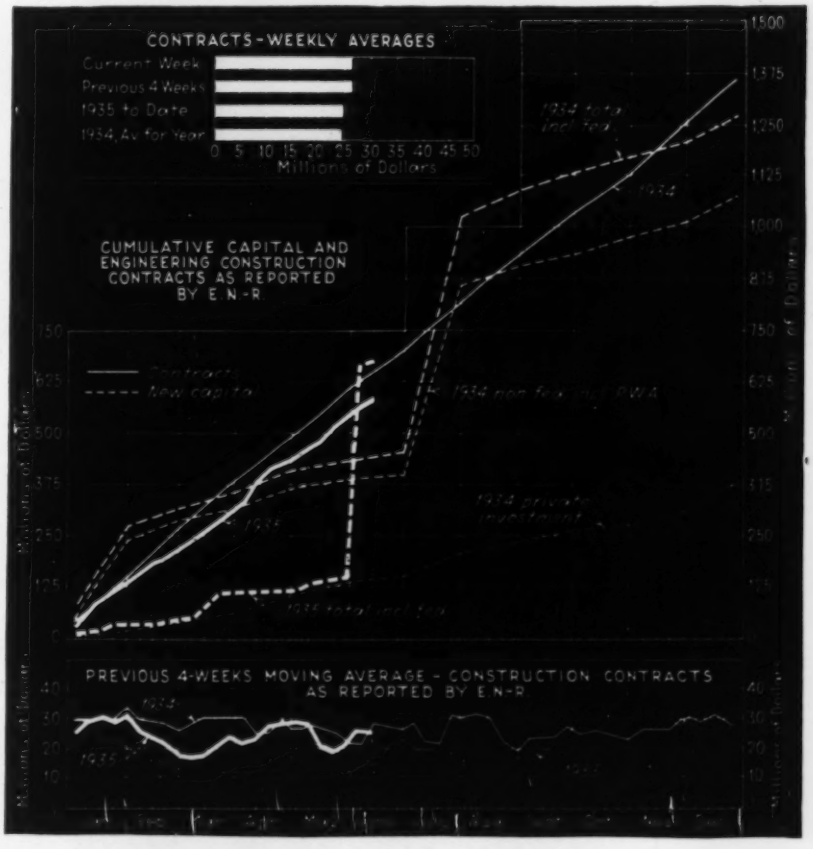
1935	Week June 13	Cumulative
State and municipal	$2,610	$183,688
PWA allotments, S&M	....	—49,032
RFC loans, S&M	....	84
Corporate issues	....	....
PWA allotments, private	....	8,619
Total, Non-Federal	$2,610	$143,359
PWA allotments, Federal Constr.	....	531,848
Total new capital	$2,610	$675,207

Cumulative to date:
1934...$441,340,000 1935...$675,207,000

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
June, 1935	194.78	93.63	May, 1935	109	52
May, 1935	194.06	93.28	Apr., 1935	130	57
June, 1934	199.61	95.95	May, 1934	101	44
1934(Av.)	198.10	95.23	1934(Av.)	114	50
1933(Av.)	170.18	81.80	1933(Av.)	102	47
1932(Av.)	156.97	75.45	1932(Av.)	127	56



Construction Equipment and Materials

Roller Bearings for Cape Cod Lift Bridge

The new 544-ft. span railway bridge over the Cape Cod Canal at Buzzards Bay, Mass., will be the first vertical-lift bridge in this country to be equipped with roller bearings. The roller bearing pillow blocks are 52½ in. high, 16 in. wide and 5 ft. long. The bearings themselves are 22 in. by 40½ in. by 17 in. According to the Bantam Ball Bearing Co., South Bend, Ind., manufacturer, the total radial load on each roller bearing will be about 600,000 lb. The vertical travel of the span is 130 ft. and the time allowed for opening or closing is two minutes.

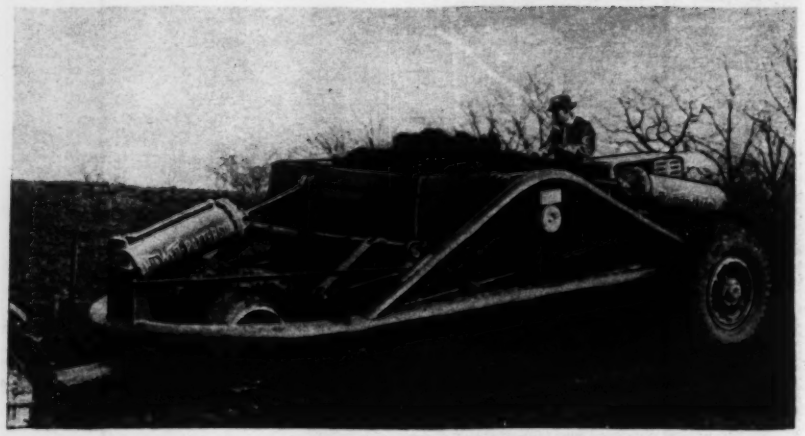
The roller bearings are of the self-aligning, straight roller type. Also, built into the bearing end caps to take any thrust loads, are special roller thrust bearings of self-aligning type. It is estimated that the use of roller bearings on the main rope sheaves will reduce friction 90 per cent, as compared with the bronze bushed bearings, and will consequently reduce the power required at each end of the span from 300 hp. to 150 hp. Steel erection on the lift span is now actively under way, and it is expected that the work will be carried out according to schedule.

New Air-Powered Scoop

An air-powered scoop of 10-cu.yd. capacity and adaptable to many purposes has been developed by the Midwest Piping & Supply Co., St. Louis, Mo. This scoop, with pneumatic control for its scraping and dumping, is mounted on a frame of large welded steel tubes that furnish an air reservoir for its operation. An air compressor mounted on the back of the scoop furnishes air power for its operation, making it unnecessary to depend upon power take-off from the tractor that pulls the scoop. The 7-ft. cutting blade will make cuts up to 12 in. in depth, depending upon the material being worked.

Besides doing away with power take-off from the tractor, the pneumatic-control system allows quicker dumping, as the scooping bowl may readily be turned to a 90 deg. angle. The bowl, when in carrying position, has a clearance of 18 in. The broad wheel base and large tires allow for easy operation over rough or muddy ground.

Another feature of this air-powered scoop is its ability to spread dirt to a depth of 25 in. The depth of the spread is equally controlled by shifting an air-valve lever.

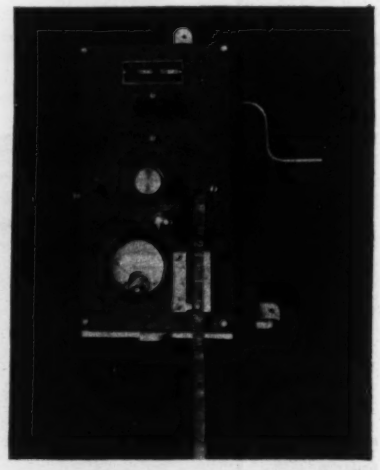


Midwest air-powered scoop.

An Electric Gage for Determining Water Level

A self-contained electric water gage designed to supplant the hook gage for measuring water level is being made by the R. C. Burt Scientific Laboratories, Pasadena, Calif. It is known as the Millipoint gage, and it is designed to read to 1/1000th of a foot. The gage has been designed in cooperation with engineers of the U. S. Forest Service.

Millipoint electric water gage.



Readings are made upon a graduated stainless-steel tape that is connected through a resistance, a milliammeter and a switch to a 4½-volt battery that is grounded to the cast-aluminum case and then to a ground connection in contact with the water, the height of which is to be measured. When a measurement is to be made, the tape is unwound until the point of a plumb bob on its lower end makes contact with the water. This contact establishes an electric circuit and causes the needle of the meter to jump. A tangent screw on the spool upon which the tape is wound provides for extremely fine adjustment.

The tape on the type 25 Millipoint gage is 25 ft. long, graduated down to 100th of a foot. An adjustable vernier makes it possible to read to 1/1000th of a foot.

New Equipment in Brief

Vibration Eliminator. A new shock absorbing cushion for machinery is being marketed by the Vibration Eliminator Co., Long Island City, N. Y. This shock absorber is a cork cushion enclosed by a metal case which is bolted to the floor and to the leg of the machinery. The Vibration Eliminator comes in various sizes depending on the load to be carried.

Diesel-powered Generator. The Harnischfeger Corp., Milwaukee, and the Caterpillar Tractor Co., Peoria, Ill., are now cooperating to build diesel-powered generator sets with the name "Harnischfeger-Caterpillar." These generator sets of the single bearing type are offered in capacities from 35 to 60 kw. for filling a.c. and d.c. requirements in mines and quarries.

Portable Pump. A fully portable, self-priming centrifugal pump is now being marketed by the Homelite Corp., Port Chester, N. Y. This pump weighs only 88 lb. complete with a built-in air-cooled gasoline engine, and handles 15,000 g.p.h. with a suction lift of 28 ft. This 3 in. pump is designed to handle muddy water with solids. The pump is built of aluminum alloy to make it light enough to be easily portable.

New Publications

WORTHINGTON VERTICAL ANGLE AIR COMPRESSORS, Worthington Pump & Machinery Corp.; Harrison, N. J. 8½x11, 6 pages.

PLATE GIRDER STIFFENER SPACING CHART, McClintic-Marshall Corp., Bethlehem, Pa. A chart for determining stiffener spacing in accordance with A. R. E. A. specifications.

LETOURNEAU POWER UNITS, R. G. LeTourneau, Inc., Stockton, Calif. 6x9, 6 pages.

LETOURNEAU ROOTER, R. G. LeTorneau, Inc., Stockton, Calif. 6x9, 4 pages.

ROBINSON HANDY REFERENCE BOOK OF CLAY PRODUCTS, The Robinson Clay Product Co., New York. 4x8, 36 pages. Catalog 35.

WORTHINGTON TYPE NO. 36 ROCK HAMMER, Worthington Pump & Machinery Corp., Harrison, N. J. 8½x11, 4 pages.

STANDARD APPLIANCES FOR ANTI-FRICTION BEARING MOUNTINGS, The Bearing Appliance Co., Ardmore, Pa. 8½x11; 12 pages.

CATALOG NO. 48, Roller-Smith Co., New York. A catalog of power factor meters, voltmeters and wattmeters.

LAWRENCE CENTRIFUGAL PUMPS, The Lawrence Machine Co., Lawrence, Mass. 6x9, 48 pages.

TRANSITE PRESSURE PIPE BROCHURE, Johns-Manville, New York, N. Y. 8½x11, 20 pages.

THE MIDWEST-PATTERSON AIR-POWERED SCOOP, Midwest Piping & Supply Co., Inc., St. Louis, Mo. 8½x11, 4 pages. Bulletin MP No. 351. A description of an air-powered dirt scoop.